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FINAL ENVIRONMENTAL IMPACT STATEMENT. PERMIT APPLICATION BY UNI--ETC(U)
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FINAL ENVIRONMENTAL IMPACT STATEMENT

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PERMIT APPLICATION BY UNITED STATES STEEL CORP. PROPOSED LAKE FRONT STEEL MILL, CONNEAUT, OHIO.

(11) 1979

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Prepared by U.S. Army Engineer District, Buffalo 1776 Niagara Street Buffalo, New York

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Traffic and Transportation Facilities

a) Highway Transportation

Ohio Regional Study Area

2.399
A map of the highways in the Ohio Regional Study Area, including the functional classification of the highways by type (with the exception of those within Ashtabula and Conneaut) is shown in Figure 2-28. The definition of each type of road (e.g., principal arterial, minor arterial, etc.), is presented in Table 2-232. The primary east-west highway providing access to the Conneaut area is Interstate Route 90 (I-90), a four-lane limited-access highway, which handles most of the Interstate traffic passing through the Ohio Regional Study Area. This highway with more than one in four vehicles traveling on it being trucks, ranks among the major truck routes in the United States. A few miles to the north is U.S. Route 20, an unlimited-access highway which parallels I-90, serves as an important intra-area link for the small cities and settlements along the northern edge of Ashtabula County. Although a four-lane highway for most of its length, it narrows to a two-lane road as it traverses the cities of Conneaut, Ashtabula, and Geneva. Currently under study is the possible extension of the Lakeland Freeway (Ohio Route 2), a limited-access highway. At present, it links the city of Painesville in the north of Lake County to the Greater Cleveland area. Ultimately, it may be extended to Conneaut, although, prior to the Spring of 1977, its extension only to the city of Ashtabula was being considered. The Lakeland Freeway Extension is in the public hearing stage of its Environmental Impact Statement and, as such, no decision has been made yet to go ahead with the construction. Should it be built, it will add east-west capacity to the Ohio Regional Study Area and will greatly reduce the congestion and delay experienced on U.S. 20.

2.400
In a north-south direction there are three major highways. The most eastward route, which parallels the Ohio-Pennsylvania border, is Ohio State Route 7, a two-lane unlimited-access highway, which joins I-80 (Ohio Turnpike) just north of the northeast corner of Youngstown, Ohio. This road is classified as a minor arterial, as shown in Figure 2-31. About six miles to the west and parallel to State Route 7 is State Route 193, a two-lane roadway and a major local collector, while another four miles to the west of SR 193 is SR 11, which connects Ashtabula and Youngstown, as well as I-90 along the northern edge of Ashtabula County with I-80 just north of Youngstown. State Route 11 is a limited-access divided highway and principal arterial. Other major collector (local) roads in a north-south direction to the west of SR 7 are SR 46, about five miles away; SR 45, five miles to

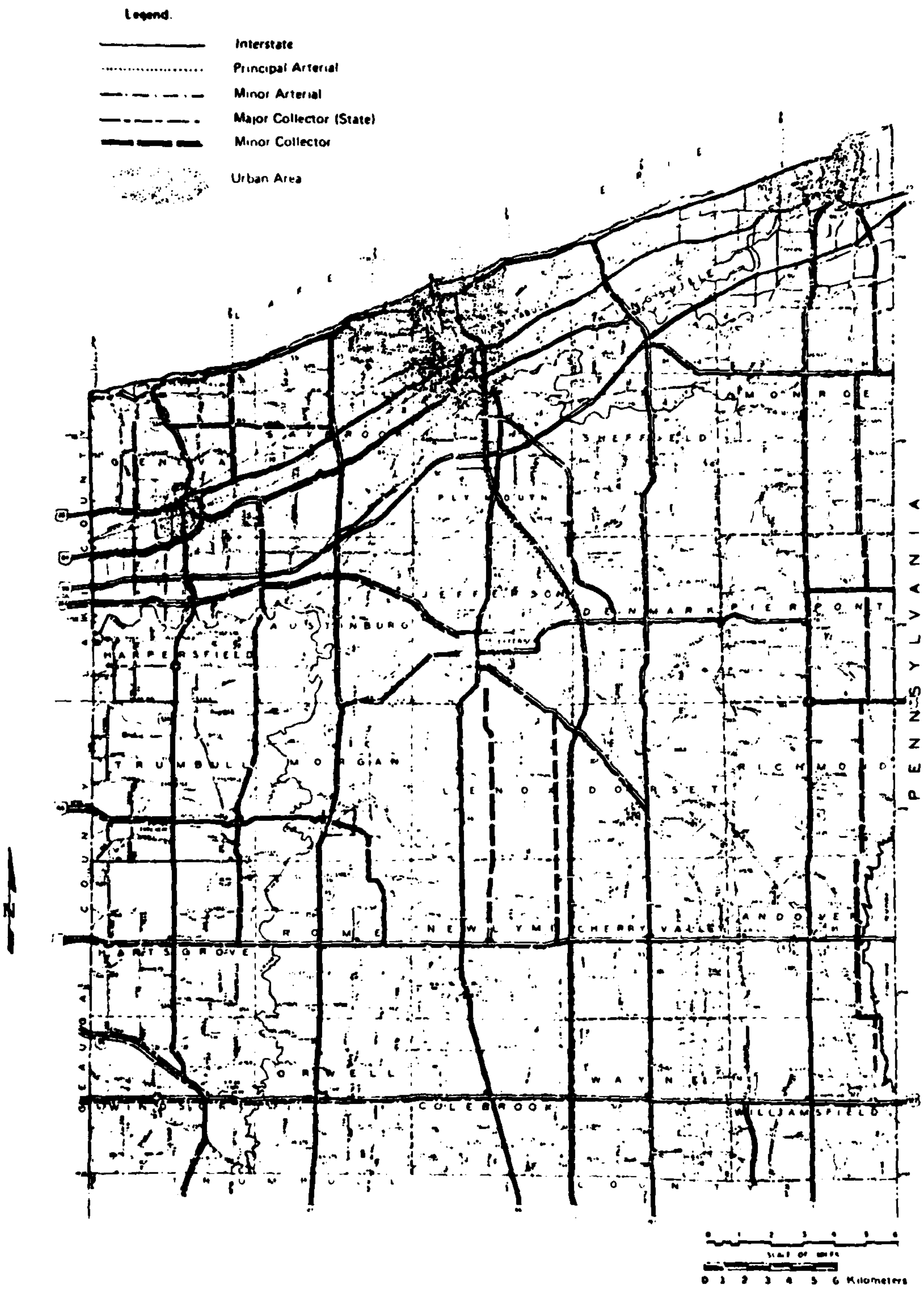

FIGURE 2–28 1975 FUNCTIONAL CLASSIFICATION SYSTEM IN ASHTABULA COUNTY

Table 2-232

Functional System Characteristics

System	Characteristics
	Rural
Interstate and Other Principal Arterials	1. Serves statewide or interstate travel. 2. Serves all urbanized areas. 3. Provides continuous statewide network.
Minor Arterials	1. Links cities and boroughs. 2. Spaced at proper intervals. 3. Relatively high design speeds.
Major Collectors	1. Provides service to urban areas not supplied by higher systems. 2. Connects routes of higher systems. 3. Serves intracounty travel.
Minor Collectors	1. Spaced at intervals to collect traffic from locals. 2. Provides service to remaining smaller communities. 3. Links local traffic generators.
Locals	1. Provides access to adjacent land. 2. Provides short-distance travel.
	Urban
Interstate, Other Freeways and Expressways, and Other Principal Arterials	1. Serves major movements within urbanized areas. 2. Integrated, internally and between major rural connections. 3. Provides continuity with rural arterials. 4. Internal service dependent on size of area.
Minor Arterials	1. Interconnects with and augments urban principal arterials. 2. Provides service to moderate-length trips. 3. Connects to rural major collectors at urban boundary.
Collectors	1. Provides service and land access. 2. Collects traffic from locals. 3. Provides traffic circulation.
Locals	1. Comprises all facilities not on higher systems. 2. Provides access to land and higher systems. 3. No through traffic.
Urban Extensions	1. Provides rural-to-rural continuity of rural arterials through urban areas. 2. May traverse the urban area from one boundary to another. 3. May simply connect to another previously-designated urban extension.

Source: Arthur D. Little, Inc.

the west of SR 46; and SR 534, five to six miles west of SR 45. These roads are all two-lane, unlimited-access roadways and carry very little traffic today.

2.401
The Highway Functional Classification System as it is expected to appear in 1990 according to the best judgments of the Ohio Department of Transportation (ODOT) are presented in Figure 2-29. By comparison to Figure 2-28 it is apparent that several minor differences in Ohio's future functionally classified highway system will occur. However, with the exception of the proposed extension of the Lakeland Freeway to Ashtabula, there are no major differences in the Ohio Regional Study Area between the future and present systems. Thus, in terms of ODOT estimates, the highway system of today is basically the same system that will exist in 1990. A functional highway classification map for the Conneaut urban area as it is expected to appear in 1990 according to ODOT estimates is contained in Figure 2-30. Also shown in this figure are 1990 level of service and AADT (annual average daily traffic).

Traffic Demand

2.402
Traffic volume (demand) is most commonly described in terms of annual average daily traffic (AADT) which is derived from actual counts made mechanically or manually. The traffic counts are made passing a specific point in the highway and generally include traffic in both directions. Thus, in this and all future discussions of traffic in this section, all traffic volumes and road capacities are two-way unless otherwise noted. The number of days in which traffic counts are made varies from a few days to a whole year; however, all AADT's are presumed to represent the average day. Obviously there are peak days and peak hours in which the average traffic is exceeded, as well as days and hours when it is not reached. Traffic data are also collected on an hourly basis. Such hourly traffic counts are then often compared with a roadway's capacity to handle such traffic. Highway capacities are usually expressed in terms of vehicles per hour that can pass a given point in both directions at the speed for which the particular highway or road was designed for safe operation. The estimation of capacity is complicated by the many factors which must be considered in its calculation. These include type of surface, number and width of lanes, roadway horizontal and vertical geometry, nature and width of shoulders, ingress and egress points, signals and signing, lighting, and weather conditions.

2.403
ODOT provided estimates of 1976 traffic flows on Ohio Regional Study Area roadways. In certain cases, the estimates are based on 1973

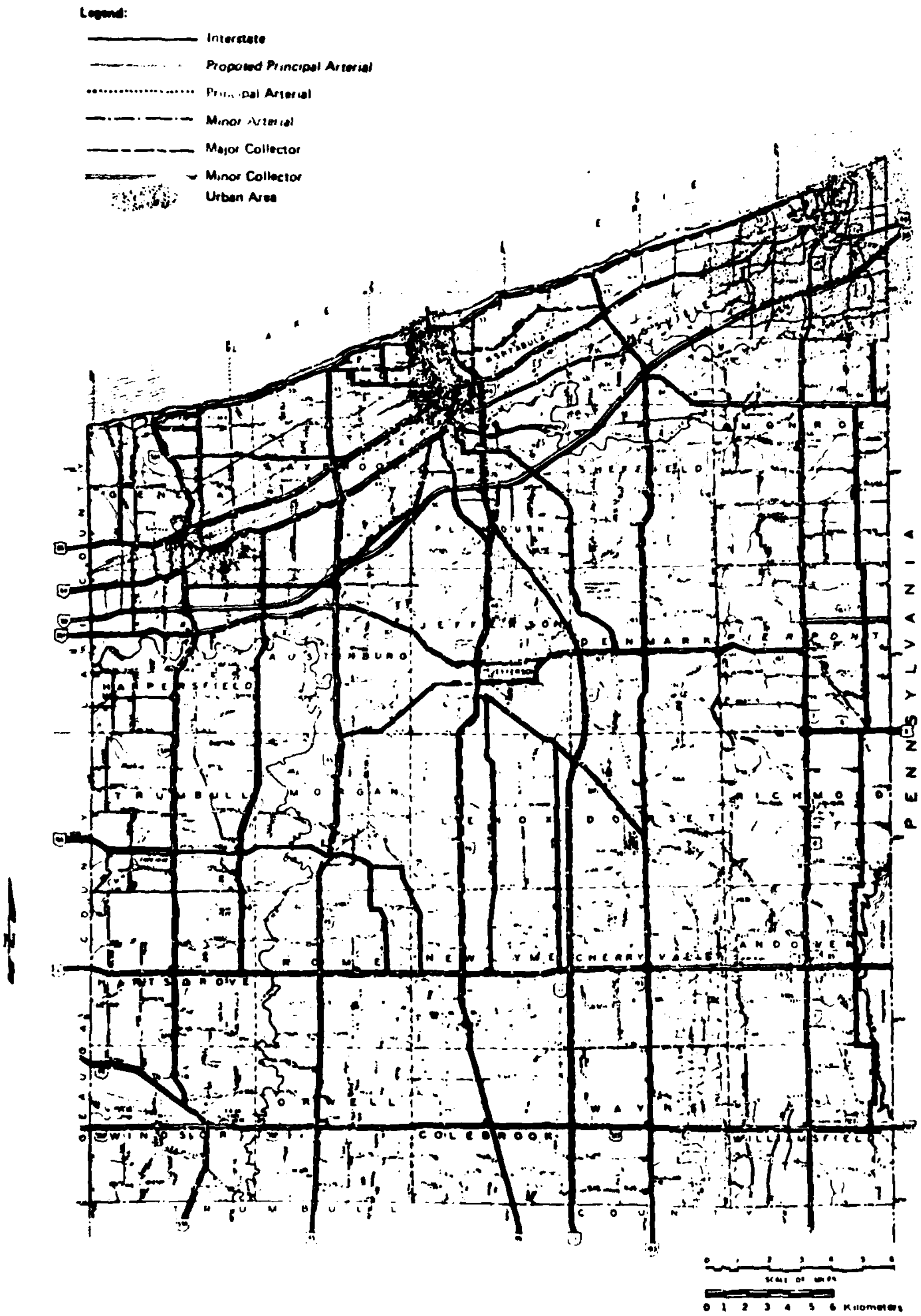

FIGURE 2–29 1990 FUNCTIONAL CLASSIFICATION SYSTEM IN ASHTABULA COUNTY

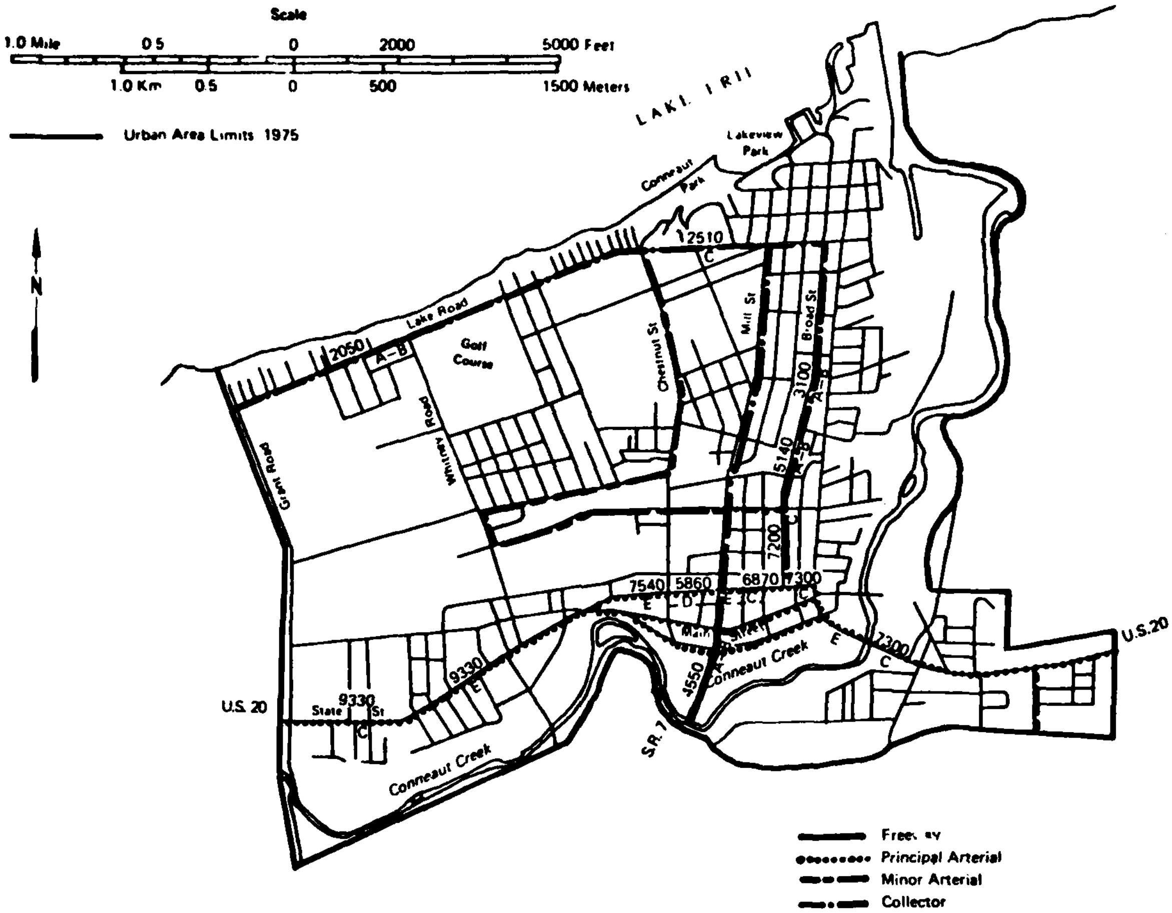

FIGURE 2–30 **1990 FUNCTIONAL CLASSIFICATION, LEVEL OF SERVICE AND AADT IN CONNEAUT**

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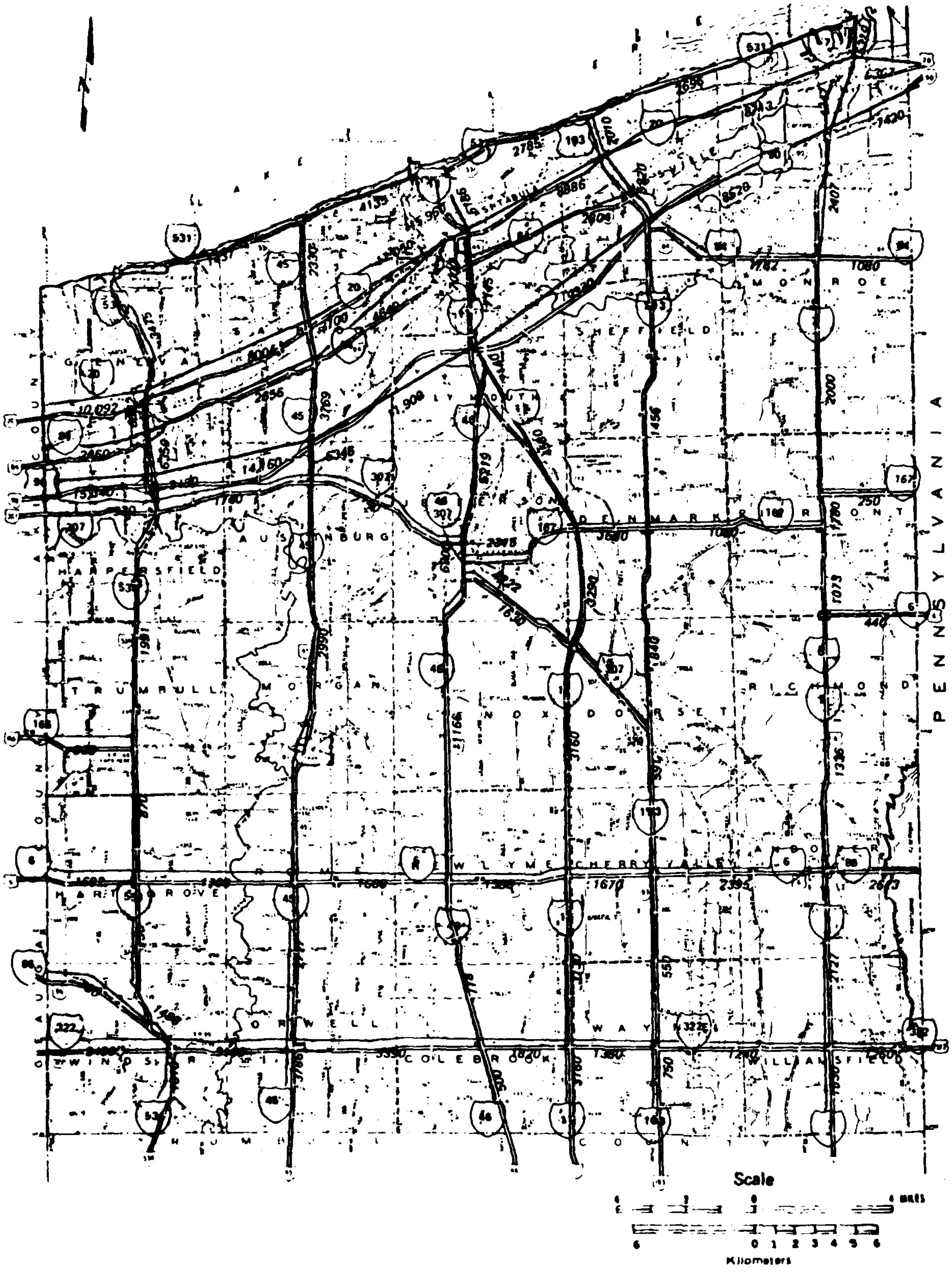

FIGURE 2–31 ACTUAL 1977 LEVELS OF TRAFFIC FLOW IN ASHTABULA COUNTY

actual counts, while in other instances actual counts taken in the winter of 1976 1977 were used. The flows shown on Figure 2-31 are two-way AADT figures. Figure 2-31 also shows that traffic on U.S. 20 peaks in Ashtabula at 15,960 and declines toward the eastern and western borders of the Ohio Regional Study Area, with a value of 6,367 at the Pennsylvania State line in Conneaut. Volumes on I-90 steadily increase from a low of 7,420 at the Pennsylvania State line to a high of 15,340 at the western boundary of the Ohio Regional Study Area. For the north-south oriented roadways, volumes are typically only several thousand or fewer vehicles per day, with increasing values in the northern portion of the area. Data on the mix of traffic by vehicle type for selected highways traversing the Conneaut corporate township limits is presented in Table 2-233. Truck traffic is a very substantial proportion of total traffic on I-90, with roughly one in three vehicles east of Conneaut being Class B (diesel-fired, single-unit) trucks or larger. The Class B designation excludes small pickup trucks often used for personal transportation even though technically they are registered as "trucks." Of the 36,810 Class B or larger trucks entering Ohio daily on State routes and the Ohio Turnpike, the heaviest concentration was along the northeastern border which includes the Ohio Regional Study Area. (2-53)

2.404
Figure 2-32 contains ODOT estimates of AADT traffic flows for 1990 in the Ohio Regional Study Area. No discernible shift in the relative importance of each highway to the others is forecast. As in 1977, traffic on U.S. 20 will be heaviest in the Ashtabula area at 23,920 vehicles per day decreasing to 11,170 at the Pennsylvania State line. Volumes on I-90 will continue to increase from east to west in the Ohio Regional Study Area. According to ODOT estimates, the traffic growth rates in Ashtabula County will be considerably lower than for the State overall, and only four of the 88 counties in Ohio will have lower annual growth rates. (2-52) Truck traffic is expected to remain the same percentage of total traffic in 1990 as it was in 1976.

Peaking Patterns

2.405
Daily traffic is higher during the summer months than during the rest of the year, as shown in Table 2-234 for the State of Ohio for a five-year average (1970-1974). Traffic also peaks at certain hours of the day. For Ohio, regardless of the type of highway, the hourly peak typically occurs between 4:00 p.m. and 5:00 p.m. On the non-interstate highways, this peak hourly traffic is about twice (1.99) average hourly traffic (i.e., the value obtained by dividing the AADT by 24 hours), or about 89 percent of the AADT. The Ohio peak hour

Table 2-233

AADT by Vehicle Class - Region 1 -- 1976 (1)

Route	Location	Total All Vehicle	Passenger Cars	Comm. Vehicle Class A	Comm. Vehicle Class B	Comm. Vehicle Class C	%Pass.Cars & Comm. Class A	%Comms.Class B & Comms Class C
SR531	NW Corp. Conneaut	2,370	2,080	220	10	60	97%	3%
US20	W Corp. Conneaut	4,700	3,820	450	250	180	91	9
US20	E Corp. Conneaut	6,930	5,580	730	420	200	91	9
IR90	W Corp Conneaut	10,230	6,750	580	2,470	430	72	28
IR90	E Corp Conneaut	8,240	4,940	450	2,450	400	65	35
SR7	S Corp Conneaut	2,560	2,050	280	110	120	91	9
All	Total.......	35,030	25,220	2,710	5,710	1,390	80%	20%

(1) AADT is 24-hour daily traffic volume, averaged over every day of the year. Region 1 corresponds to the Conneaut Corporate limits.

Source: Ohio Department of Transportation records.

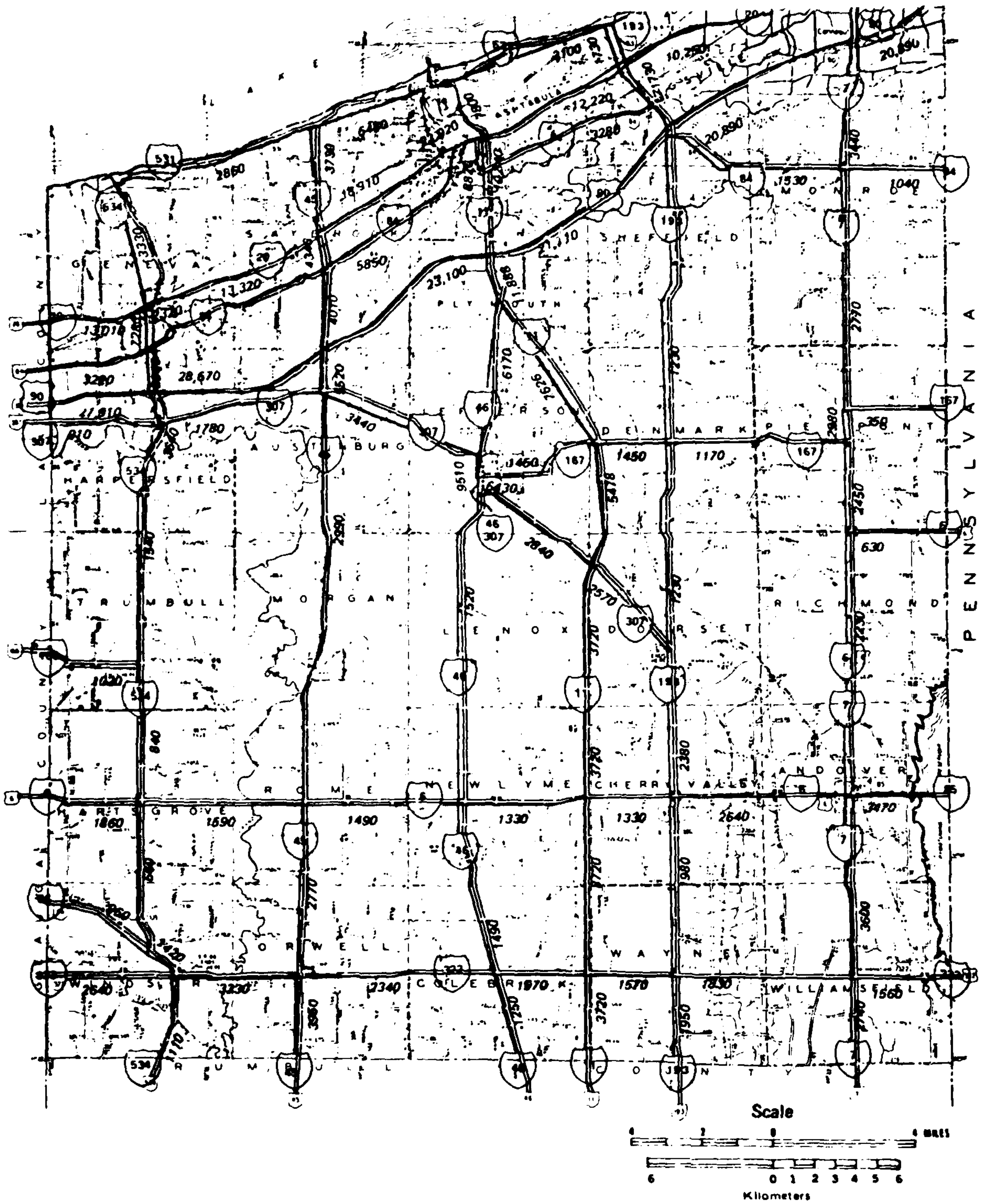

FIGURE 2–32 ESTIMATED 1990 LEVELS OF TRAFFIC FLOW IN ASHTABULA COUNTY

Table 2-234

Ohio Average Daily Traffic Volume Increase During Peak Month[1]

Highway Type	Peak Month	% Increase Over ADT
Rural Interstate Highways	August	30%
Rural State Highways	August	12
Urban Interstate Highway	June	6
Urban State Routes & Local Arterial	June	6

[1] Based on a five-year average, 1970-1974.

Source: Ohio Transportation Facts, 1975, Ohio Department of Transportation.

and 13th highest hour ratios for four specific highway types are presented in Table 2-235. The 30th highest hour factor is an arbitrary point in the distribution of yearly demand employed by Ohio and other States in establishing design volumes for a given highway. In other words, the roadway will be designed with sufficient capacity to accommodate anticipated traffic throughout the year, with the exception of the 30 highest hours (i.e., after occasional major traffic-generating events). Peak hours are taken into consideration in arriving at level of service estimates for various highways. In the section which deals with the probable traffic impacts of the proposed U.S. Steel facility at Conneaut, these data will be employed to estimate the changes, if any, that can be expected in the level of service on the highway network in the area.

Level of Service

2.406
A method which brings together demand and capacity to arrive at a description of traffic conditions on a given road segment is called "level of service." The definitions of each level of service are presented in Table 2-236. A map of the Ohio Regional Study Area which identifies those highway segments currently experiencing a level of service of D or worse is shown in Figure 2-33. Those highway segments in which the level of service will be D or worse by the year 1990, based on ODOT's forecasted baseline traffic volumes are shown in Figure 2-34. According to these estimates congestion currently experienced on U.S. 20 in Ashtabula will spread eastward six or seven miles toward Conneaut and about the same distance westward toward Geneva. It will also spread a mile or so south on SR 84 from U.S. 20 on the westerly edge of Ashtabula. Congestion will also be experienced for the first time on U.S. 20 as it traverses Geneva and is reduced to three lanes, and on SR 534 as it exits to the south of the city of Geneva. A stretch of SR 46 in the downtown area of the city of Jefferson for less than a mile will have some problems as will a mile stretch on SR 45 between I-90 and SR 307. This latter congestion spot is expected to occur due to narrow ten-foot lanes. With the exception of the small stretch on SR 45, the only problem areas in terms of congestion would be in the downtown areas identified above and on the roads leading into and out of those areas where the number of homes, retail stores, fast-food shops, etc., is expected to continue to increase. It should be noted that the Conneaut area retains a level of service rating on all of its highways of C or above, as does the main east-west highway, I-90, and the north-south road, SR 7.

Table 2-235

Ohio Peak Hour and Thirtieth Highest Hour Ratios[1]

Highway Type	Peak Hour Ratio[2]	30th Highest Hour Ratio[3]
Rural Interstate Highways	1.68	2.69
Rural Non-Interstate Highways	1.99	2.64
Urban Interstate Highways	1.92	2.35
Urban Non-Interstate Highways	1.99	2.50

(1) For 1973

(2) Ratio of weekday (Monday through Thursday) peak hour traffic (occurring at 4:00 p.m.) to average hourly traffic.

(3) Ratio of 30th highest traffic volume hour of the year (used as a design basis) to average hourly traffic for a year.

Source: Ohio Transportation Facts, 1975, Ohio Department of Transportation.

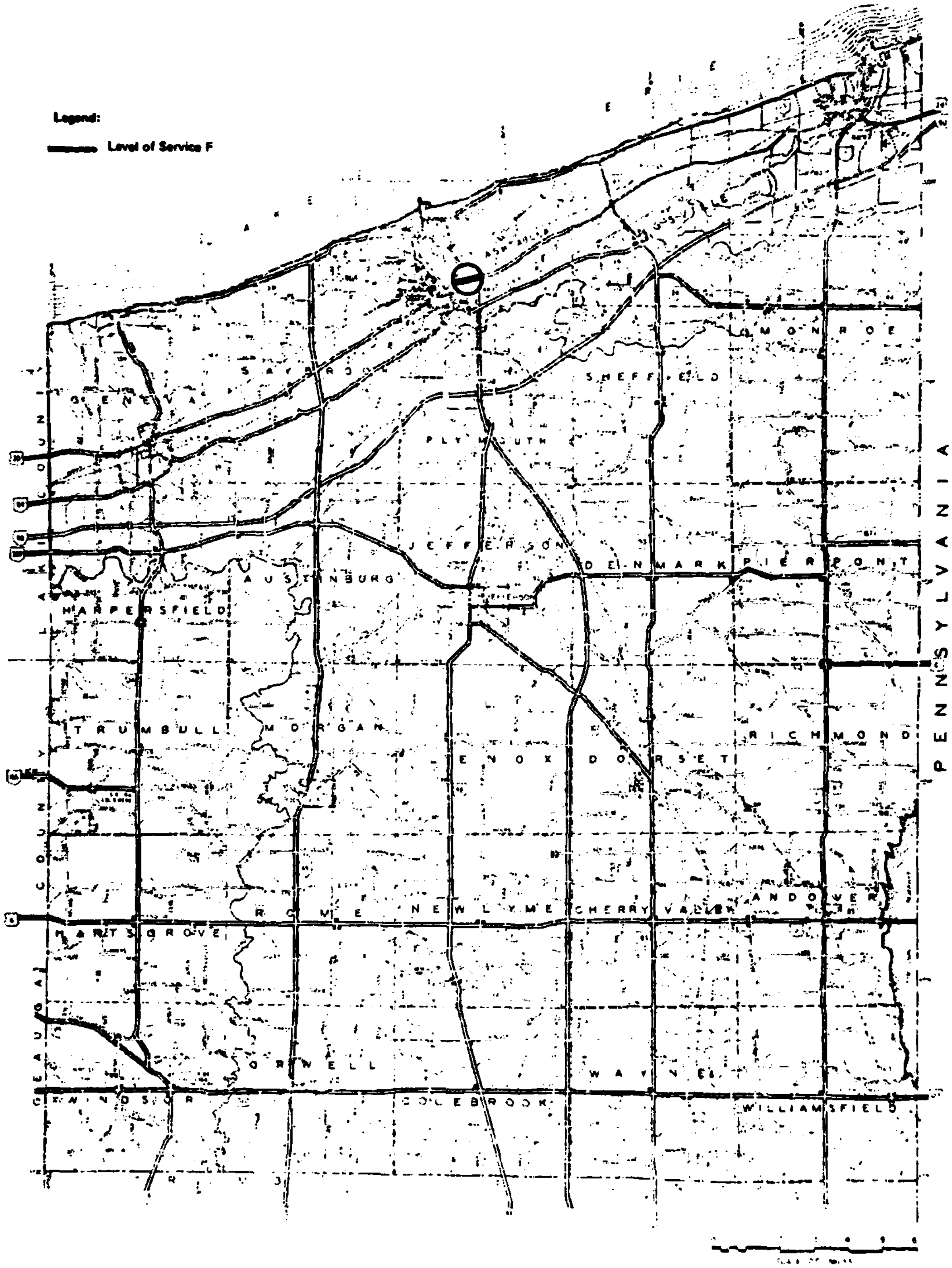

FIGURE 2–33 EXISTING LEVEL OF SERVICE D OR WORSE IN ASHTABULA COUNTY

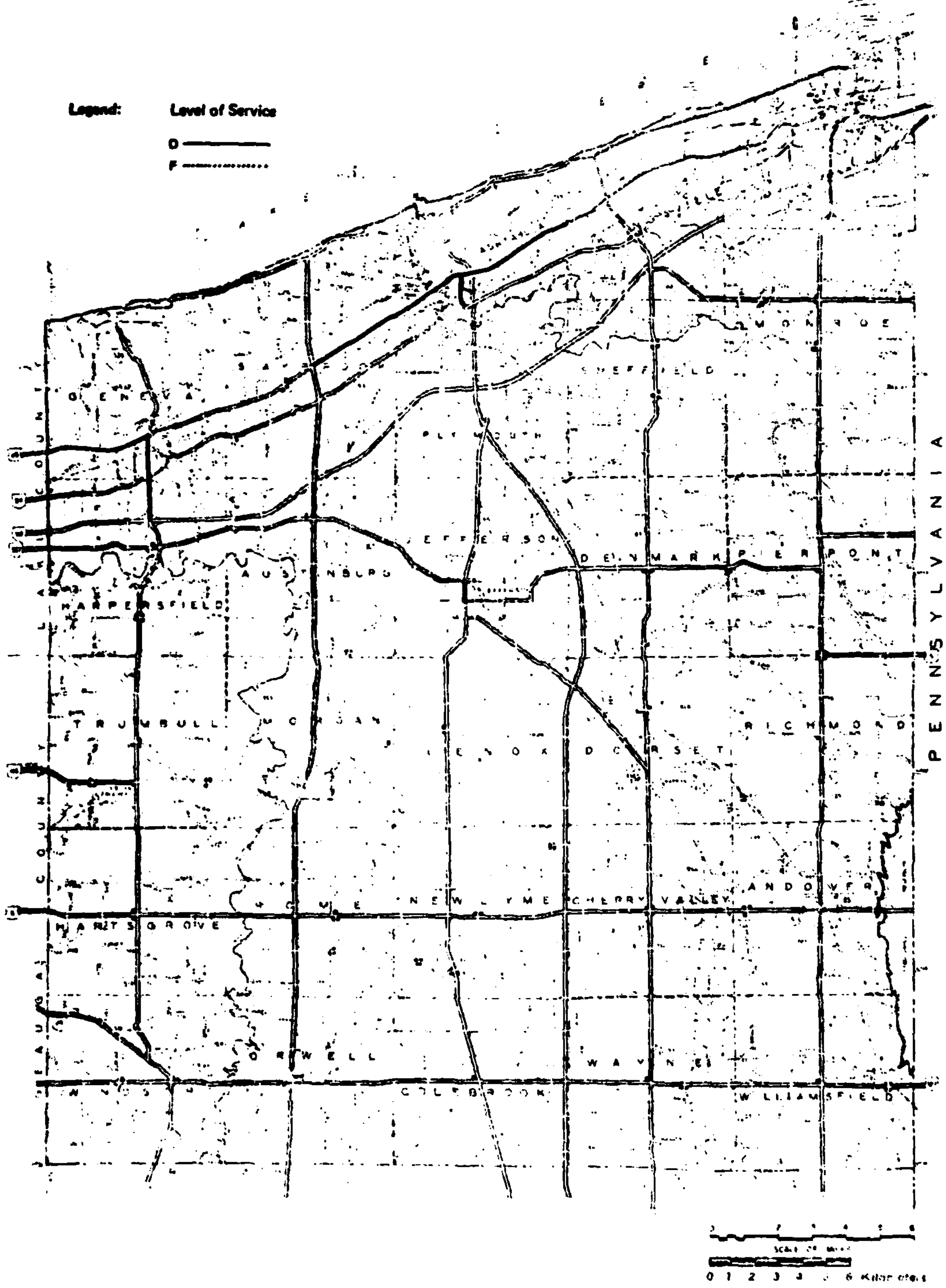

FIGURE 2–34 1980 LEVEL OF SERVICE IN ASHTABULA COUNTY

Table 2-236

Level of Service Definitions[1]

Level of Service A:	Describes a condition of free flow, with low volumes and high speeds.
Level of Service B:	Describes a condition of stable flow with operating speeds beginning to be restricted somewhat by traffic conditions.
Level of Service C:	Describes a condition of stable flow but with speeds and maneuverability more closely controlled by the higher volumes.
Level of Service D:	Describes a condition of unstable flow with tolerable operating speeds considerably controlled by higher volumes.
Level of Service E:	Describes a condition of unstable flow with operating speeds controlled by volumes at or near the capacity of the roadway.
Level of Service F:	Describes a condition of forced-flow operation at low speeds, where volumes are above capacity.

---

(1) Operating speeds associated with each level of service will vary according to the type of roadway and its urban/rural character.

Source: Arthur D. Little, Inc.

Other Highway System Characteristics

2.407
Deficient highway bridges in the Ohio Regional Study Area are identified in Figure 2-35. The problem is extensive and spread throughout Asntabula County. Depending on the nature of the deficiencies, which vary from load limits to clearance problems, certain traffic, especially truck traffic, can be reduced or totally curtailed. A map showing the location of planned improvements of both roads and bridges through the projection period up to 1990 is contained in Figure 2-36. The sequence and timing for implementation of these improvements is subject to funding availability and the occurrence of additional needs that cannot presently be foreseen. The bridge over Conneaut Creek on Route 20 will be resurfaced within a year. It has excellent load-bearing strength, since it was designed to handle trolley cars. It is now and will continue to have single-lane capacity in each direction. The restriction to one lane each way reduces traffic volume capability since U. S. 20 is generally four lanes wide between Conneaut, Ohio, and Erie, Pennsylvania. Traffic congestion in downtown Conneaut is generally not a problem. However, localized traffic congestion could be nearly eliminated by proper designation of one-way street patterns, new traffic signalization, and more and improved parking. (2-53) The biggest traffic problem facing Conneaut will continue to be the absence of needed grade-separated railroad crossings. With more than 100 freight trains passing through the city each day (some of which stop and move into classification yards), the city's streets are often bisected for extended periods of time by moving or stopped trains. Although frequently discussed, neither the railroads (Conrail and the Norfolk & Western) nor the city have any plans (or funds) to correct the problem. Other than the railroad crossings, the principal highway problem in Conneaut is maintenance of city streets and roads. This is unlike most other small cities in Ohio, where the roads beyond the immediate central business district are maintained by either the State or the county. However, the joining of another township with Conneaut years ago and the resultant reorganization, expanded highway maintenance responsibilities to include both the city and township. Of the 112 miles of road in Conneaut, a significant portion is dirt or gravel, while the remaining paved roads are generally in poor condition, especially after the winter when frost heaves occur. The patching of roads keeps the highway department almost fully occupied during the temperate seasons of the year.

Vehicle Ownership

2.408
In 1974, there were 54,256 passenger cars registered in Ashtabula County and 19,207 other vehicles, including pickup trucks, larger

Key:

□ Bridge posted, deficient structurally (Legal load less than 100%) (State Highways)

○ Bridge general condition deficient, functionally (Vertical clearance less than 14' 6")
Note: Structural condition of bridges on county highways not known.

● Low load type of pavement

▲ Pavement width less than 14'

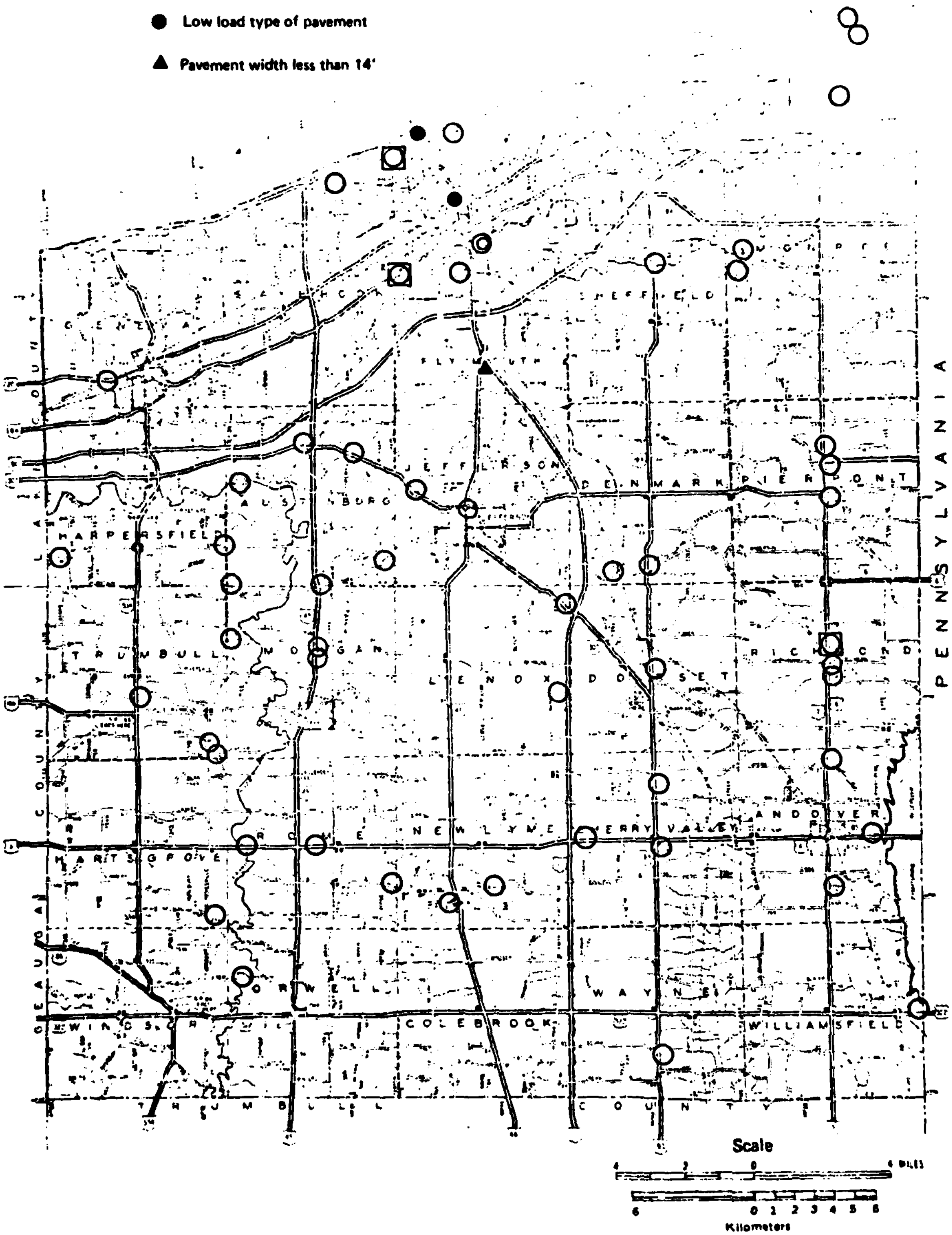

FIGURE 2–35 1977 PHYSICAL DEFICIENCIES IN ASHTABULA COUNTY

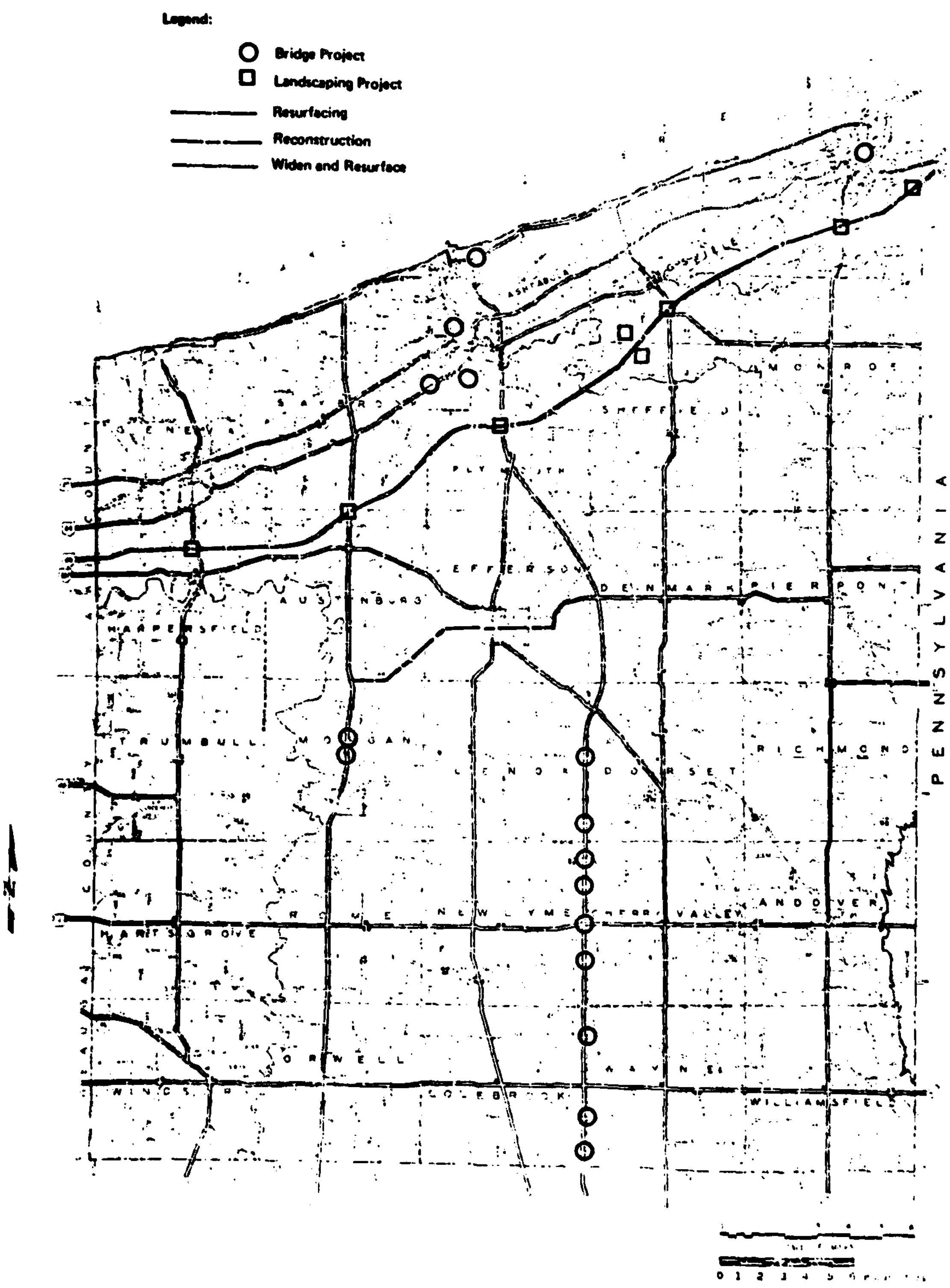

FIGURE 2–36 STATE HIGHWAY IMPROVEMENT PROGRAM IN ASHTABULA COUNTY 1977–1990

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trucks and tractors, and publicly-owned vehicles and buses, for a total registration of 73,463 vehicles. Assuming that vehicle registration will increase at the same rate as the population, it is expected that there will be 79,080 vehicles registered by 1990. It is further projected that of this total, 58,405 vehicles will be passenger cars.

Highway Passenger and Freight Service Facilities

2.409
Points within Ashtabula County are served by Class I highway common carriers that include some of the largest firms in the nation, as well as a number of companies with more restricted interstate operating rights. Limited bus and taxi service exists in the area. The Cleveland to Buffalo Greyhound bus route has four buses daily in each direction (east and west), all of which stop in Conneaut. Conneaut has no municipal buses. The only city in the county with municipal bus service is Ashtabula City, which has one 20-passenger jitney bus and five 52-passenger buses used mostly for charter service. Conneaut has two taxi companies, each operating two vehicles. The city of Ashtabula also has two taxi companies with a total of 10 taxis.

Pennsylvania Regional Study Area

2.410
The highways in the Pennsylvania Regional Study Area including a functional classification of the highways by type are shown in Figure 2-37. The definition of the Highway Functional Classification Systems (HFCS) is presented in Table 2-237. Interstate Route 90 (I-90) is a four-lane, limited access highway and provides primary east-west access and handles most of the interstate traffic passing through the Pennsylvania Regional Study Area. As in Ohio, I-90 is the major truck route, and is paralleled to the north by U.S. 20, which is a four-lane, unlimited-access highway, except for a four-mile stretch in Erie City and a two-mile stretch in West Springfield. North of U.S. 20 and paralleling the lake shore is State Route 5 (SR 5), which is a two-lane, unlimited-access highway, except for a 10-mile, four-lane stretch in Erie City. Both U.S. 20 and SR 5 serve as an intra-area link for the settlements along the northern edge of Erie County. The major north-south highway in the Pennsylvania Regional Study Area is I-79, which runs from Erie City south and connects with I-76 (the Pennsylvania Turnpike) just north of Pittsburgh. This is a four-lane, divided highway with limited access. Five other major highways which are classed as minor arterials are: U.S. 6N, which originates at U.S. 20 three miles east of the Ohio-Pennsylvania line, connects with I-90, runs south for four miles, and then turns east; SR 18, eight miles farther to the east of U.S. 6N, which runs

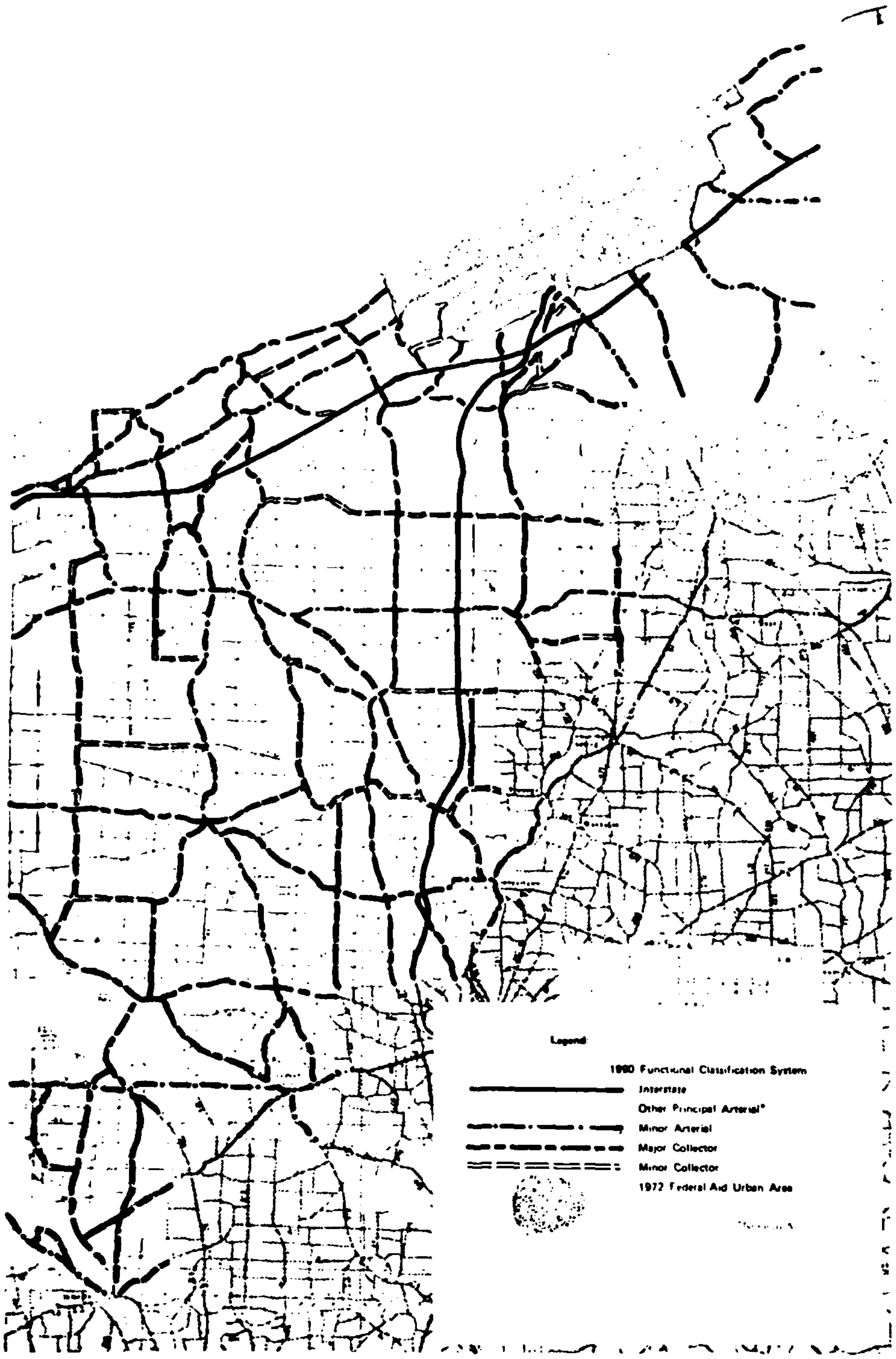

FIGURE 2–37 RURAL AREA HIGHWAY FUNCTIONAL CLASS IN THE PENNSYLVANIA REGIONAL STUDY AREA – 1980

Table 2-237

Functional Classification System in the Pennsylvania Regional Study Area -- 1980

	Miles
Erie County	
Rural	
Interstate	60.5
Other Principal Arterial	0
Minor Arterial	76.0
Major Collector	85.4
Minor Collector	118.5
Total Rural	340.4
Urban (Erie Urban Area)	
Urban Principal Arterial	
Interstate	5.9
Urban Extension	22.9
Other Principal Arterial	36.8
Urban Minor Arterial	57.0
Urban Collector	80.2
Total Urban	202.8
Total Erie County	543.2
Crawford County	
Rural	
Interstate	13.0
Other Principal Arterial	0
Minor Arterial	55.5
Major Collector	90.0
Minor Collector	95.5
Total Rural	254.0
Total	797.2[1]

[1] Does not include 1099.1 miles in Erie County and 535.8 miles in Crawford County of local classified roads owned by the State and local municipalities.

Source: Pennsylvania Department of Transportation.

south to join U.S. 6 near Conneaut Lake; U.S. 19, which runs south from Erie City to join I-79; and SR 8 and SR 430, which run east from the east side of Erie City. These roads are generally two-lane with unlimited access, except in the Erie City area where some have been widened to four lanes. There are four major collector highways which run south from near the shore of Lake Erie. SR 215, six miles east of the Ohio-Pennsylvania line, originates at SR 5, connects with U.S 20 and I-90, and joins U.S. 6N. SR 98, which also originates at SR 5 and connects with U.S. 20 and I-90, joins U.S. 6 near Meadville. SR 99 originates south of Erie City and joins U.S. 6 near Cambridge Springs. SR 97, originating in Erie, connects with I-90 and continues south to join U.S. 19 near Waterford. All of these roads are two-lane, undivided, unlimited access highways. The 1990 Highway Functional Classification System (HFCS) is shown in Figure 2-38. Due to drastic limitations in the Pennsylvania Department of Transportation's (PDOT) capital improvements program, the 1990 classification of rural highways is essentially the same as Figure 2-39, since no major highway improvements are anticipated between 1900 and 1990.

Traffic Demand

2.411
A map of the Pennsylvania Regional Study Area roadways with AADT figures, based on 1973 actual counts is presented in Figure 2-39. From this data, it is apparent that traffic on I-90 builds progressively from west to east, being 12,000 at the Ohio line and greater than 20,000 in the vicinity of Erie City. Traffic on U.S. 20 and SR 5 shows similar characteristics. Volumes on I-79 taper off slightly heading south from Erie and are in the 10,000-vehicle-per-day range. Traffic on other roadways in the Pennsylvania Regional Study Area is generally very light. Table 2-238 presents 1975 AADT traffic volumes on several roadways in the Springfield area. The AADT's do not show the percentage of truck traffic, but the percentage of truck traffic on I-90 may be expected to be similar to that in Ohio (approximately 30 percent). Projected AADT's for 1990 are shown in Figure 2-40.

Peaking Patterns

2.412
Traffic volume peaks in summer, being eight percent higher than the AADT in June in urban areas and 10 percent higher than the AADT in May through August in primary rural areas. The 30th highest hour of traffic volume occurs between 4:00 p.m. and 5:00 p.m. and on Friday for more than 35 percent of the continuous traffic recorder stations. The 30th highest hour traffic volume averaged over the 47 continuous traffic recorder stations accounts for 12.8 percent of the AADT,

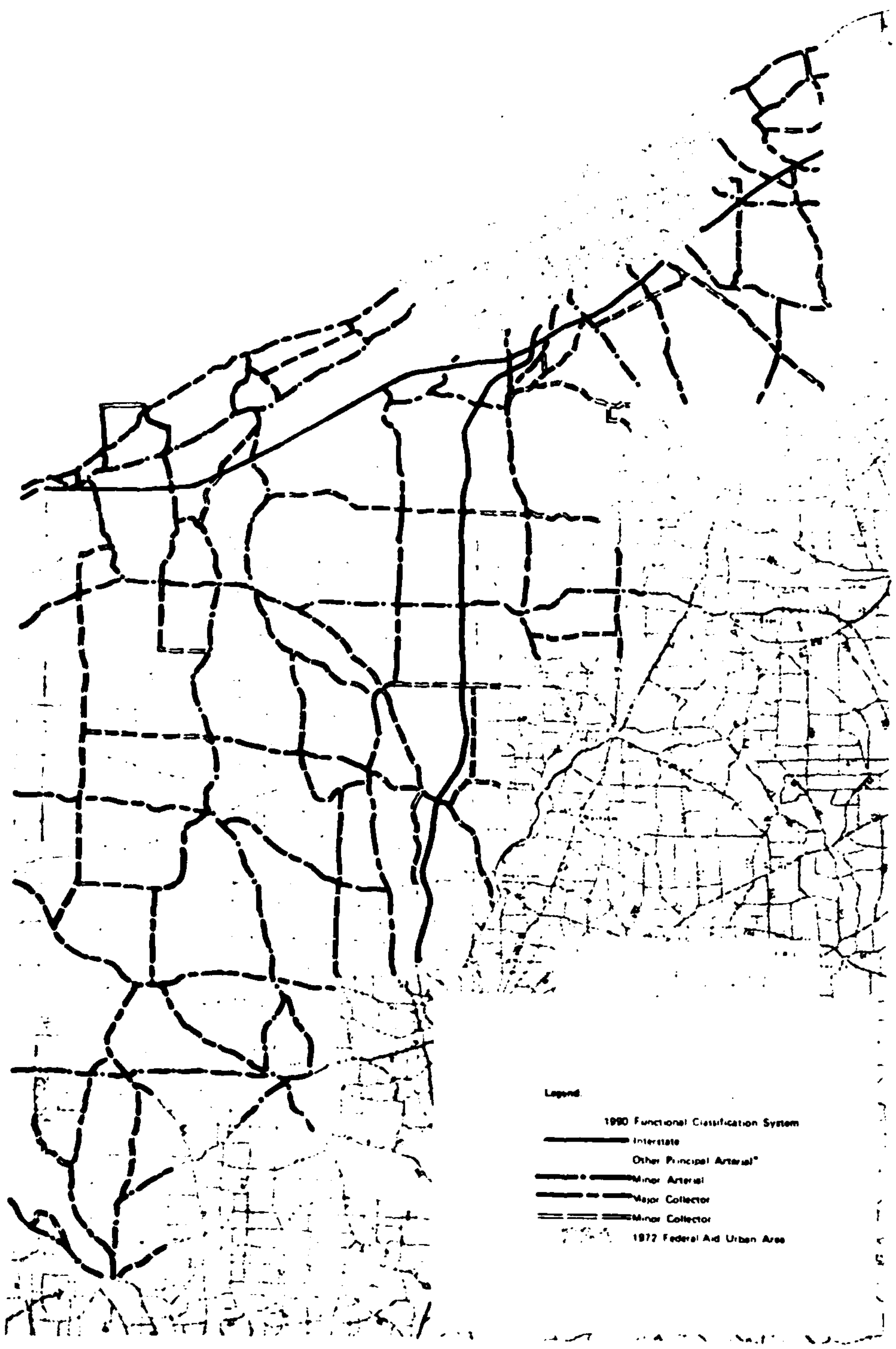

FIGURE 2-38 RURAL AREA HIGHWAY FUNCTIONAL CLASS IN ERIE COUNTY – 1990

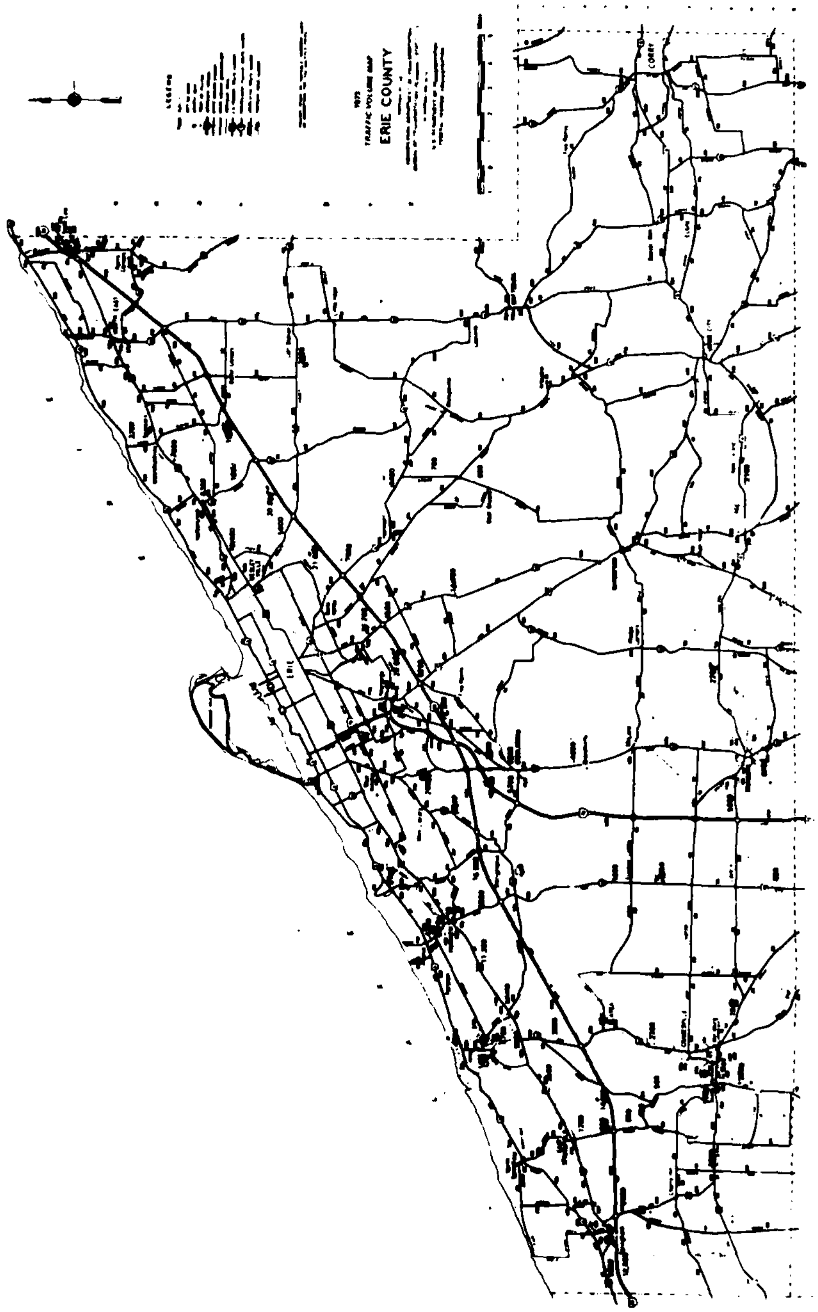

FIGURE 2–39 1973 PENNSYLVANIA AADT'S

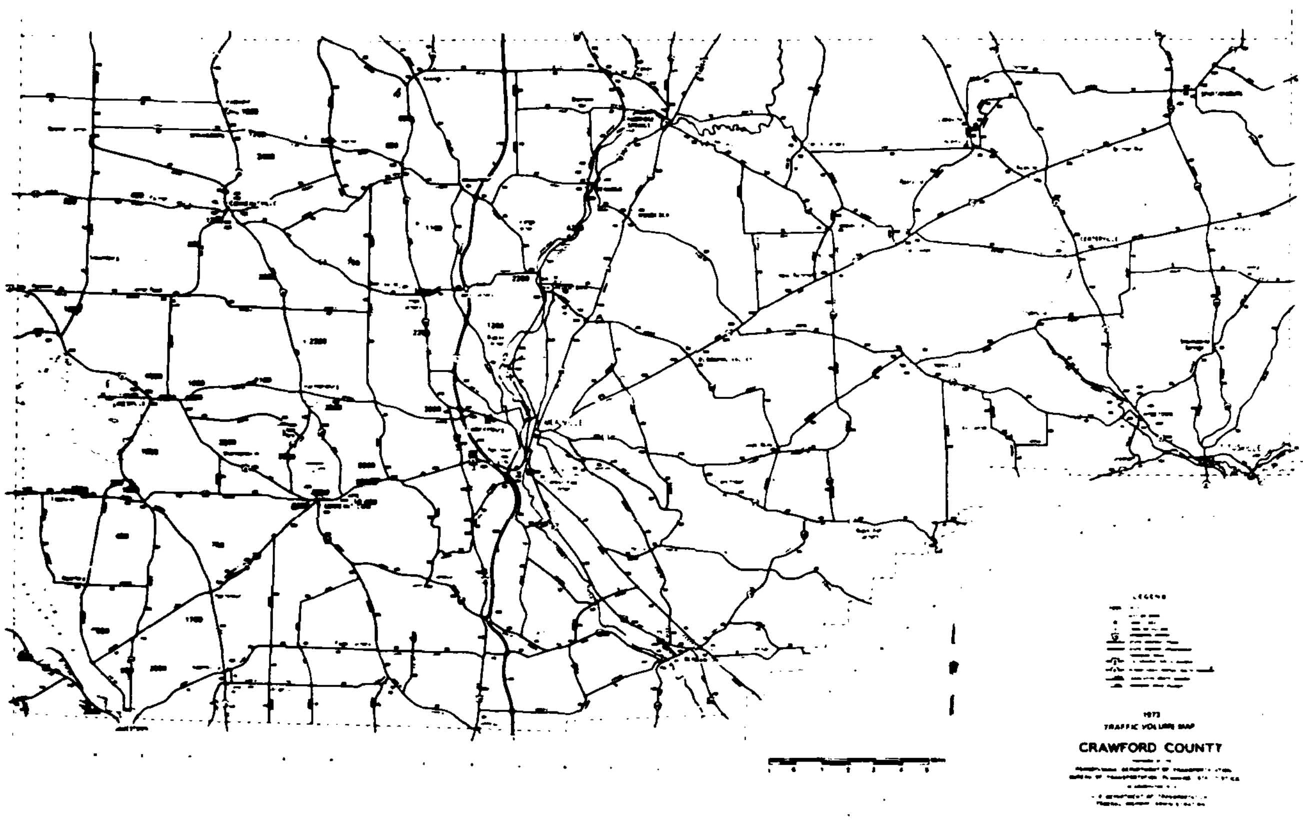

FIGURE 2–39 (Continued)

Table 2-238

Annual Average Daily Traffic Volume in the Springfield Area -- 1975

	1975 AADT
Interstate 90	
State line to Route 6N	12,000
Route 6N to Route 215	14,500
Route 215 to Township line	14,400
U.S. Route 20	
State line to Route 5	5,000
Route 5 to Crayton Road	3,700
Crayton Road to Route 6N	4,000
Route 6N to Nash Road	3,300
Nash Road to Main Street	3,300
Main Street to Route 215	3,300
Route 215 to Borough line	2,700
U.S. Route 6N	
Township line to Griffey Road	1,800
Griffey Road to I-90	2,000
I-90 to Route 20	2,000
U.S. Route 5	
Route 20 to Crayton Road	1,500
Crayton Road to Nye Road	1,200
Nye Road to Eagley Road	1,350
Eagley Road to Route 215	1,400
Route 215 to Township line	1,300
PA Route 215	
Township line to Old Albion Road	500
Old Albion Road to I-90	850
I-90 to Neiger Road	850
Neiger Road to Main Street	1,000
Main Street to Route 20	1,200
Route 20 to Happy Valley Road	550
Happy Valley Road to Route 5	400
Route 5 to Old Lake Road	600
Old Albion Road	
Route 215 to Township line	400
Crayton Road	
Route 20 to Route 5	300
Nye Road	
Route 20 to Route 5	200
Eagley Road	
Route 5 to Old Lake Road	270
Old Lake Road	
Eagley Road to Route 215	270

Source: "Springfield Area Background Analysis and Comprehensive Land Use Plan," Erie Metropolitan Planning Department, March 9, 1977.

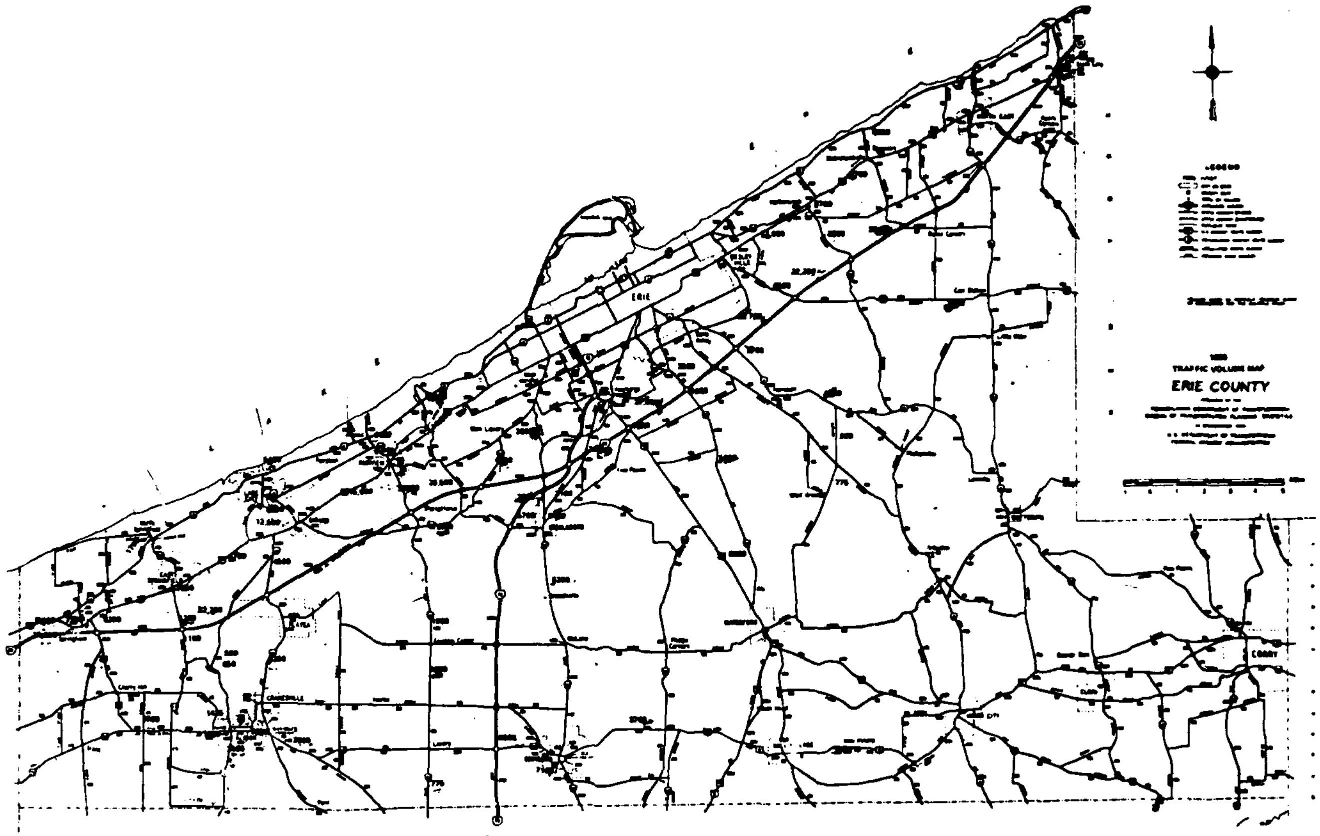

FIGURE 2-40 1990 PENNSYLVANIA AADT'S

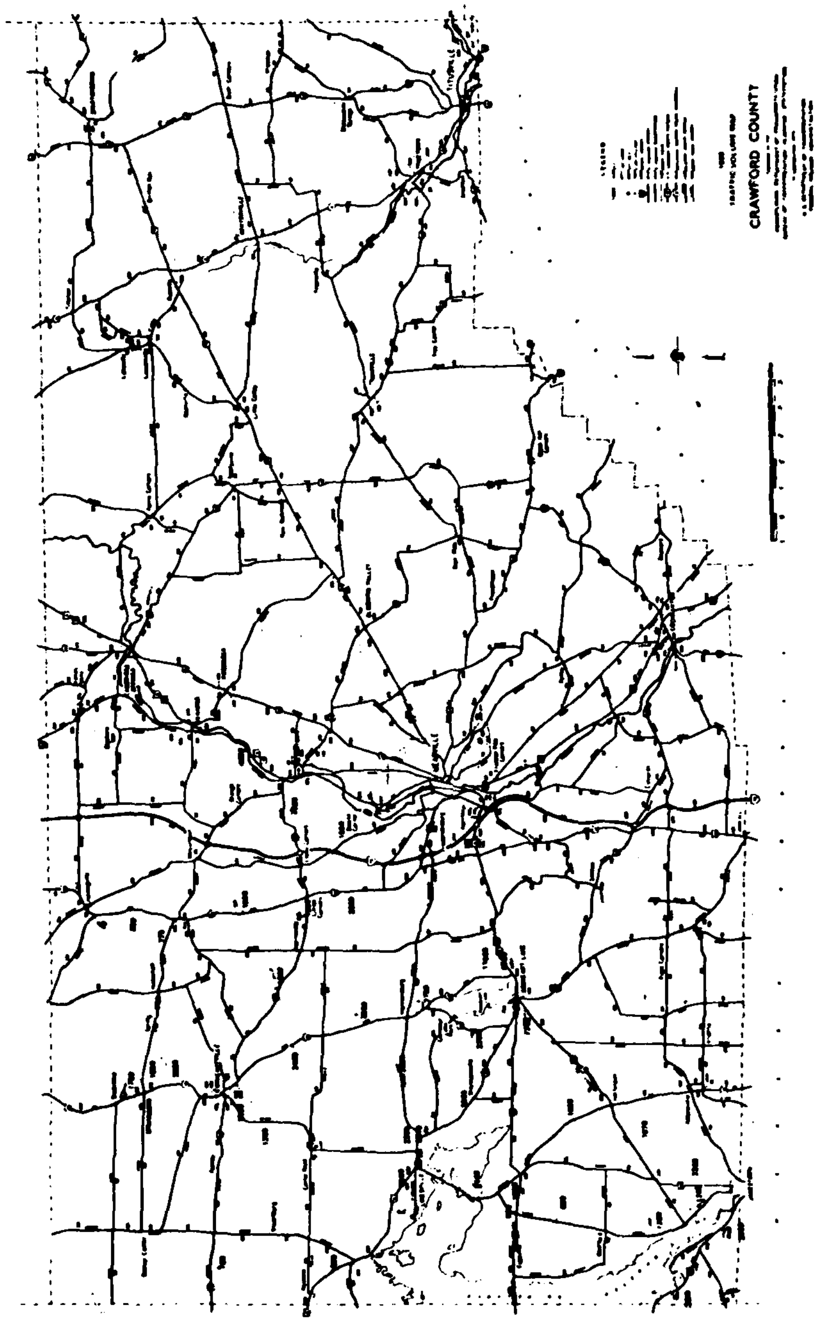

FIGURE 2-40 (Continued)

yielding a 30th hour to AADT peak ratio of 3.07. Station 1, a continuous traffic recorder station located on U.S. 20 about one-half mile east of the Ohio-Pennsylvania State line in West Springfield, had a 1976 30th hour to AADT peak ratio of 2.69 which occurred between 5:00 p.m. and 6:00 p.m. on Friday, 23 July. The other two automatic traffic recorder stations (on I-90 one mile east of the State line and on Pennsylvania SR 5 about 0.2 miles east of the Erie City line) did not record continuously in 1976, due to construction on I-90 and equipment failure on SR 5.

Level of Service

2.413
Those highway segments currently experiencing a level of service of D or worse are identified in Figure 2-41. Highways attaining a level of service of D are listed below:

SR 5, for a four-mile stretch just west of Erie,

SR 18, between SR 5 and U.S. 6N,

SR 215, south of I-90,

Road 20018, southwest of Erie, between SR 832 and SR 99,

Road A64 between SR 18 and SR 98,

U.S. 6N, for 1.5 miles east of Albion,

SR 198 from the Ohio-Pennsylvania line through the Study Area,

SR 18 south from Conneautville to SR 618,

Road 25038 south from Conneautville for four miles,

Road 25046 east from Linesville, and

Road 25006 south from Linesville for four miles.

SR 18 currently has a level of service of E for 3.5 miles south of SR 618. Those capacity deficiencies of most significance to the study are in SR 5, SR 18, and SR 215. A total of 82 miles of rural arterial and major collectors are currently operating at level of service of D or worse during the peak hour period. A map which projects level of service D or worse for those highways through the year

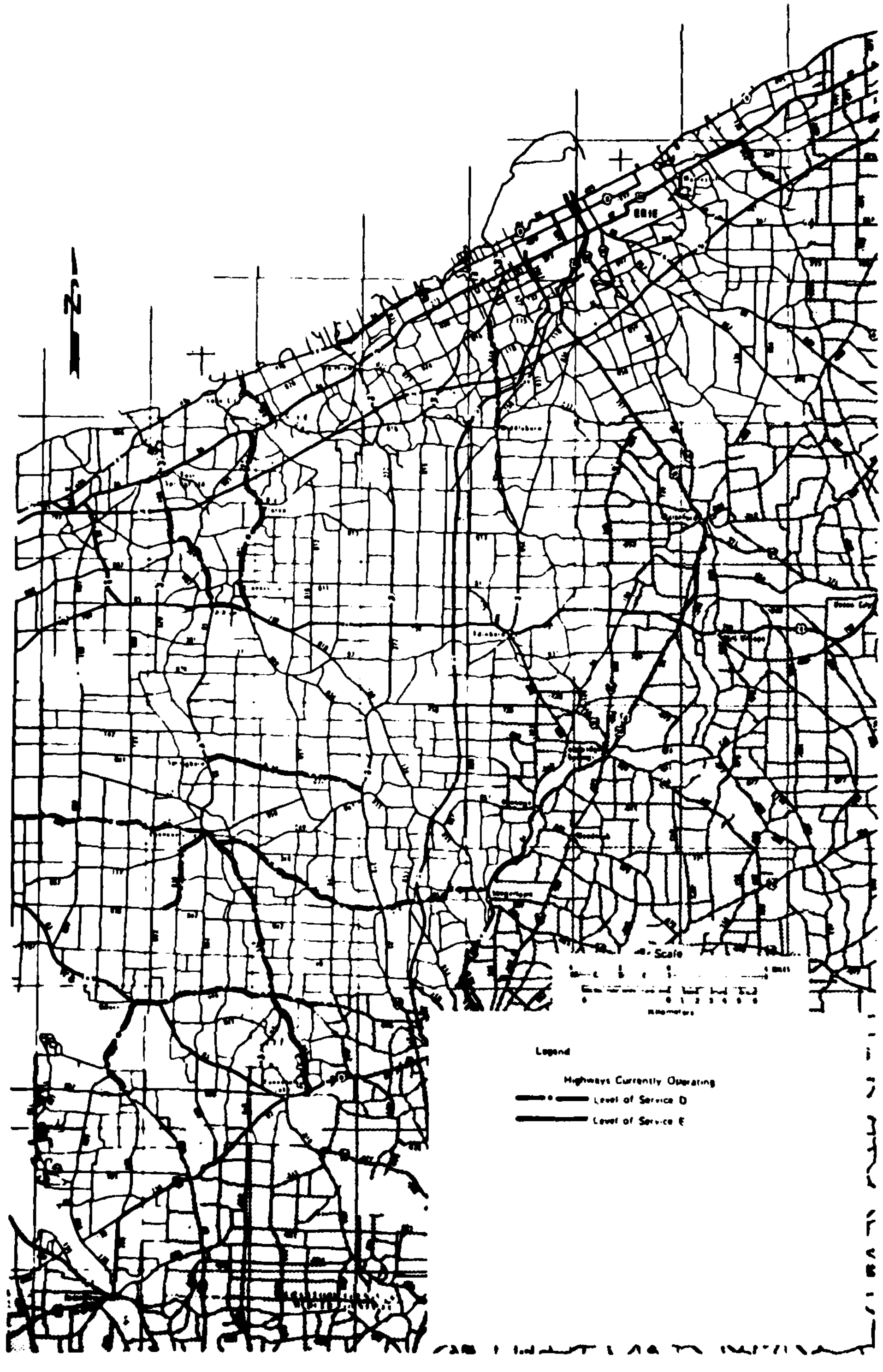

FIGURE 2-41 ERIE COUNTY CAPACITY DEFICIENCIES – CURRENT

1990 is presented as Figure 2-42. The same capacity deficiencies are projected as currently exist, with the following changes:

- SR 5, which was formerly level D, becomes level E;
- SR 198, for a two-mile stretch starting 1.5 miles west of I-79, changes to a higher level of service;
- SR 18, for a two-mile stretch south of Conneautville, changes to a higher level of service;
- Road 25038 south of Conneautville changes to a higher level of service;
- Road 25006 south of Linesville changes to a higher level of service;
- I-90, from SR 18 to SR 430, becomes level of service D;
- SR 99, from Middleboro south through the Study Area, becomes level of service D;
- U.S. 6N, from SR 99 west for four miles, becomes level of service D;
- U.S. 6, in the southeastern part of the Study Area, becomes level of service D; and
- SR 98 south from 198 to Study Area limits becomes level of service D.

The congestion in SR 5 west of Erie occurs where the number of lanes decrease from four to two, and becomes worse in 1990, changing from level of service D to E. The volume of traffic on I-90 for a 22-mile stretch south of Erie becomes heavy enough in 1990 to make it level of service D. Most of the other capacity deficiencies show minor changes between today and 1990. It should be noted that U.S 20 and I-79 maintain a level of service C or better in 1990, as do I-90 and the smaller roads in Springfield Township, with the above-noted exception of SR 215. It is estimated that, in 1990, 117 miles of rural arterial and major collector highways will be operating at level of service D or worse during the peak hour period, 35 miles more than today.

Other Highway System Characteristics

2.414
Existing deficiencies in the State highway system in the Pennsylvania Regional Study Area as categorized by: narrow (less than 18 feet)

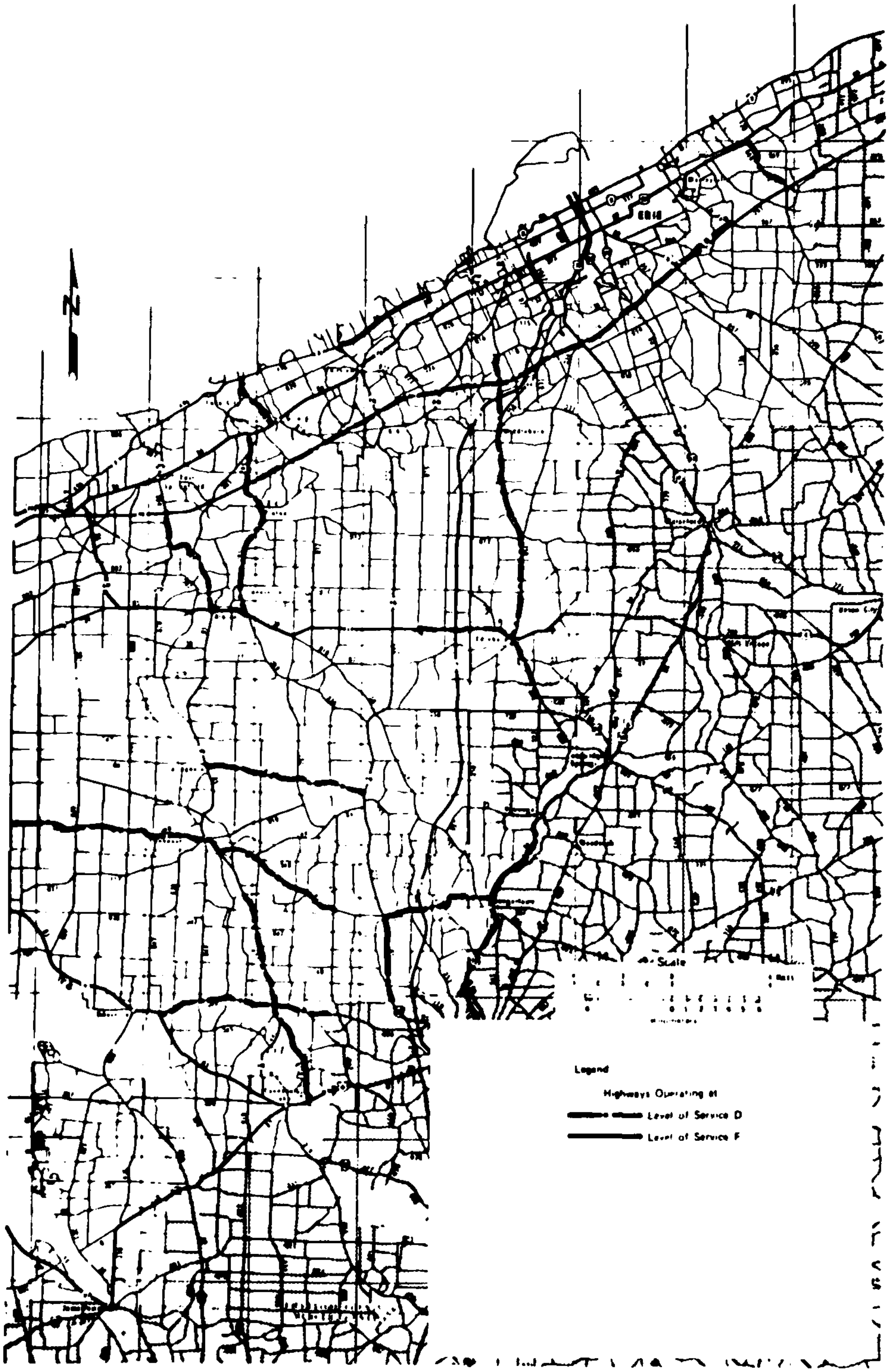

FIGURE 2–42 ERIE COUNTY CAPACITY DEFICIENCIES –1990

roadway; low (load-bearing) -type pavement; bridge load restrictions; and underpass restrictions of 14 feet or less. Presently there are 152 miles of highway with less than 18-foot roadways, 126 miles of highway with a light flexible pavement or worse, 26 bridges with load restrictions, and 15 bridges with vertical clearance of 14 feet or less. These deficiencies are illustrated in Figure 2-43. Although a number of existing structural deficiencies will be eliminated, some bridges which are now adequate will become structurally deficient by 1990. It is estimated that nine such bridges will be in the Pennsylvania Regional Study Area. It is anticipated that only 42 miles of highway in the area will have the low-type pavement and only 30 miles will have less than 18-foot roadways. Projected deficiencies for the State highway system through the year 1990 are shown in Figure 2-44. In the Springfield area, 35.5 miles of State road are paved while 1.25 miles are oil-based. In East Springfield Borough, 4.25 miles are paved and 0.85 mile is dirt. In Springfield Township, 18.1 miles are paved and 41.9 miles are dirt. Detailed information on selected roadway characteristics in the Springfield area are presented in Table 2-239. Speed limits in the Springfield area range from 35 mph to 55 mph. There are no fixed-time, traffic-control signals in the area, but there are intersection warning signals (red and yellow flashing) at the Crayton Road/ U.S. 20 intersection and the U.S. 6N/U.S. 20 intersection. Stop sign intersection control is used throughout the area, although there are a number of T-type and cross-type intersections on local roads that are not signed. The 102 miles of public roads in the area include 36.75 miles of State road (32.5 in Springfield Township and 4.25 in East Springfield Borough), and over 65 miles of local roads (60.0 miles in the Township and 5.1 miles in the Borough). The Pennsylvania Department of Transportation (PDOT) has one project planned in the Springfield area. It involves the widening and resurfacing of Old Lake Road for 1.1 miles beginning at Eagley Road and ending 3,100 feet west of the intersection of SR 215, Holliday and Old Lake Roads. The existing roadway, 14 feet in width, will be widened with a five-inch bituminous concrete base, three feet left and right. The total roadway will then be resurfaced with a 2.5-inch bituminous surface course and the shoulders will be reconstructed four feet left and right. Completion of work on Old Lake Road should be accomplished by the end of fall 1977. There are 20 rail intersections (at-grade crossings) meeting with the highway system in the Springfield area. These are listed in Table 2-240.

Vehicle Ownership

2.415
Motor vehicle registration for Erie and Crawford Counties as of 31 December 1975 was as shown in Table 2-241. Assuming that vehicle registration increases at the same rate as population, it is presented that there will be about 237,000 vehicles in Erie County in

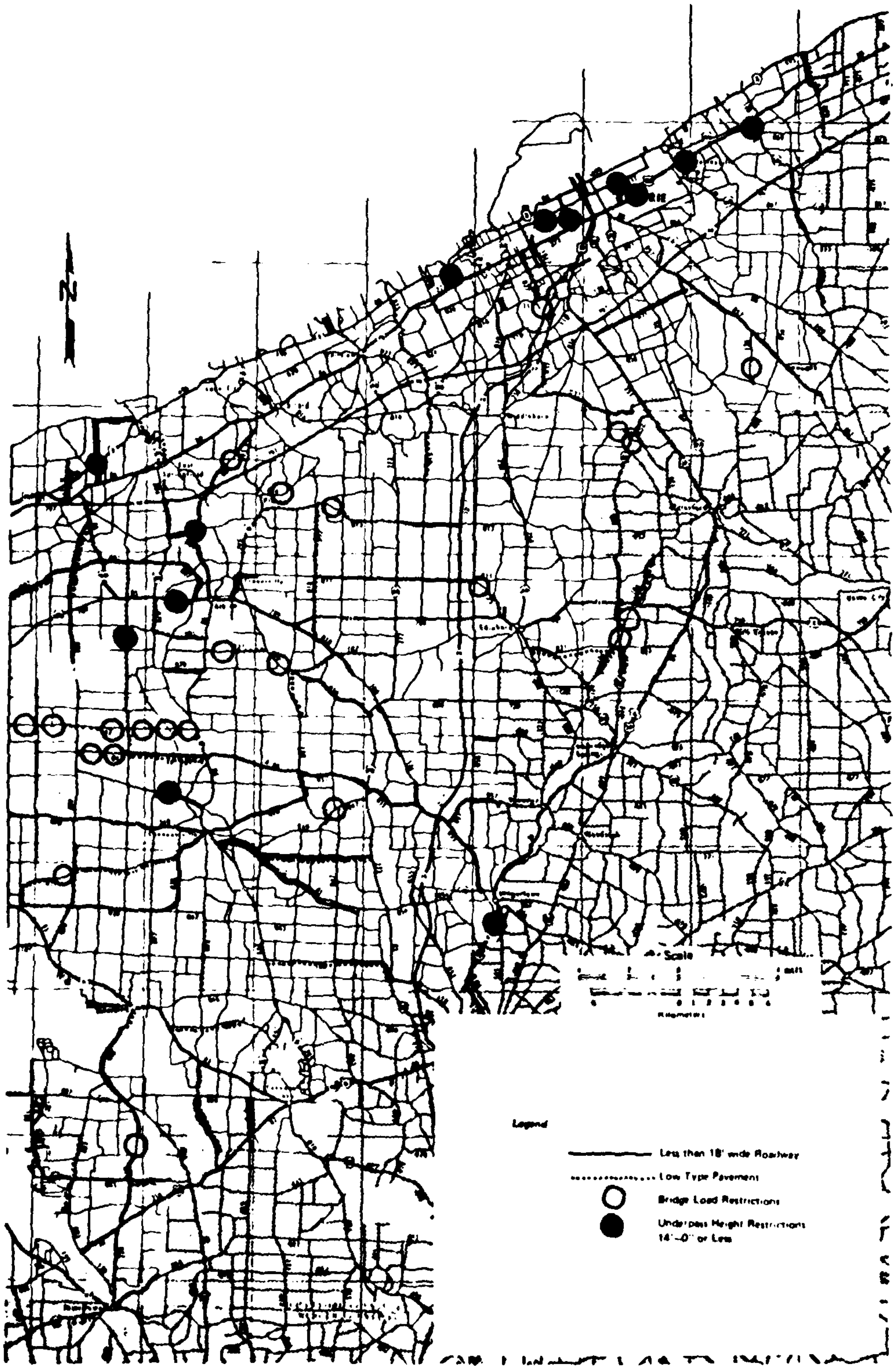

FIGURE 2–43 ERIE COUNTY PHYSICAL DEFICIENCIES – CURRENT

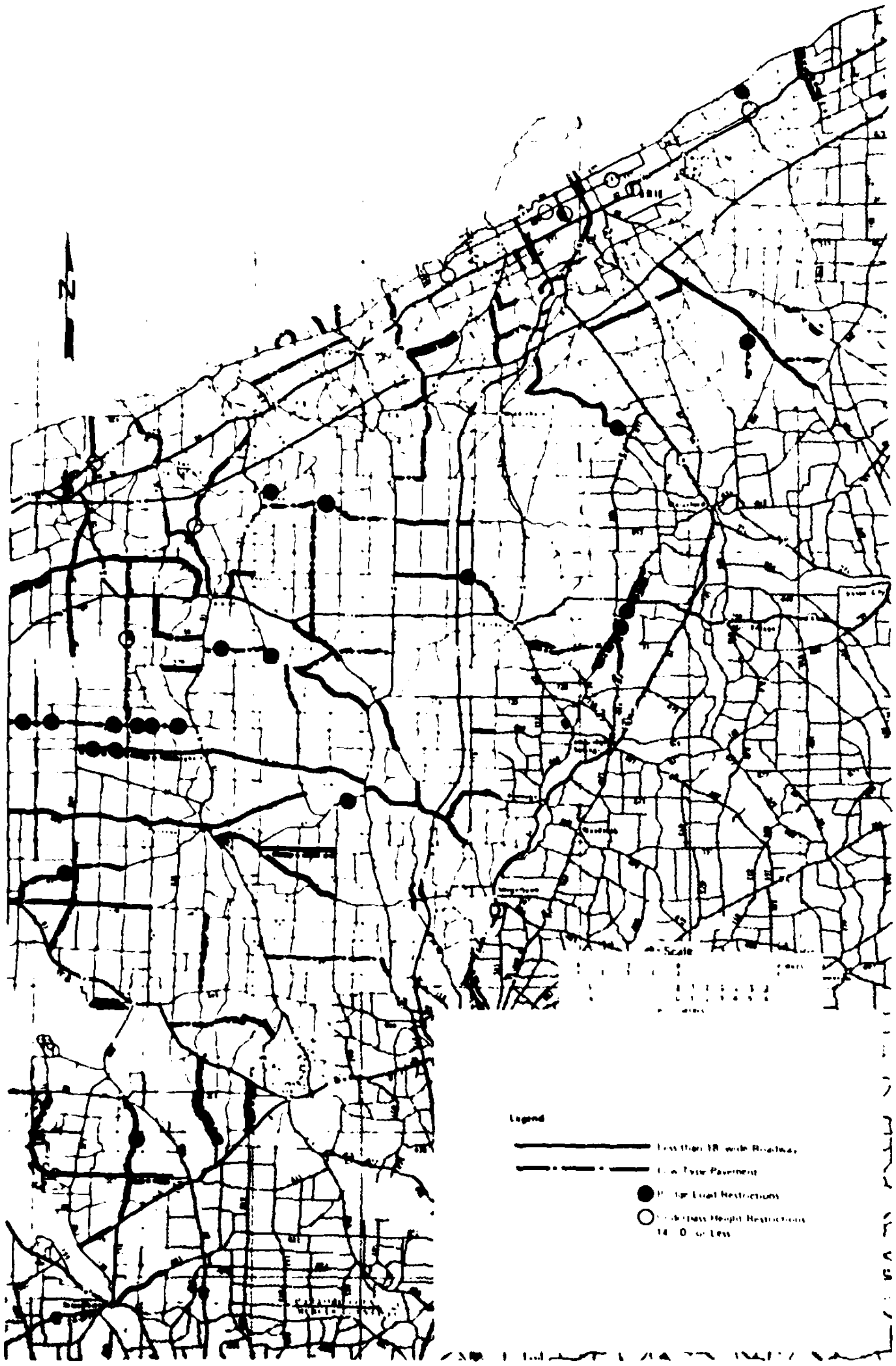

FIGURE 2–44 ERIE COUNTY PHYSICAL DEFICIENCIES – 1990

Table 2-239

Roadway Characteristics in the Springfield Area

Jurisdiction	Road Name	Right-of-Way	No. of Lanes Other Than 2	Road Type
Pennsylvania	I-90	176'	4	Concrete
	Route 20	70' - 120'	3 & 4 (part)	Concrete & bituminous
	Route 6N	50' - 80'	4 (part)	Concrete & bituminous
	Route 5	50' - 70'		Bituminous
	Route 215	50' - 60'		Bituminous
	Crayton, Nye, Old Albion, Eagley, and Old Lake Roads	50'		Bituminous
	Griffey Road	50'		Oil base
East Springfield Borough	Main and (a portion of) Academy Streets, Neiger, Tubbs, McKee, and (a portion of) Happy Valley Roads	50'		Bituminous
	Bond and (a portion of) Academy Streets	40'		Bituminous
	Lucas, Rich and (a portion of) Happy Valley Roads	50'		Dirt
Springfield Township	Chestnut Street	80'		Concrete
	Happy Valley, McChesney, Scott, Nash, Steinberg, Main, Sanford, Coon Creek, Stoker, Neiger, and (portions of) Holliday, Old Lake, Elmwood, McKee, Wheeler, Huntley and Underridge Roads	50'		Bituminous
	The remainder of Township Roads	50'		Dirt

Source: "Springfield Area Background Analysis and Comprehensive Land Use Plan," Erie Metropolitan Planning Department, March 9, 1977.

Table 2-240

Railroad at-Grade Crossings and Bridges in the Springfield Area

Railroad Name	Road Name	Type of Device	Road Function
ConRail	State Line Road	Warning signs	Local
	Rudd Road	Warning signs	Local
	Lynch Road	Warning signs	Local
	Elmwood Road	Warning signs	Local
	Ellis Road	Warning signs	Local
	Eagley Road	Signal lights	Minor collector
	Route 215	Signal lights	Minor collector
	Ables Road	Warning signs	Local
Norfolk and Western	State Line Road	Warning signs	Local
	Rudd Road	Warning signs	Local
	Crayton Road	Warning signs	Local
	Route 5	Bridge	Major collector
	Nash Road	Warning signs	Local
	Scott Road	Warning signs	Local
	Route 215	Signal lights	Minor collector
	Happy Valley Road	Warning signs	Local
	Lucas Road	Warning signs	Local
	Townline Road	Warning signs	Local
Bessemer and Lake Erie	Pond Road	Warning signs	Local
	Huntley Road	Warning signs	Local
	Route 6N	Bridge	Minor arterial
	McKee Road	Bridge	Local
	Route 215	Gated signal lights	Major collector

Source: "Springfield Area Background Analysis and Comprehensive Land Use Plan," Erie Metropolitan Planning Department, March 9, 1977.

Table 2-241

Motor Vehicle Registration as of December 31, 1975

Vehicle Classification	Erie County	Crawford County
Passenger and suburban	158,605	48,506
Motorcycle	9,712	3,691
Schoolbus, bus and taxi	610	339
Tractor	681	262
Truck, truck/tractor and trailer	41,084	17,603
Commercial	989	368
Fire department	221	116
All other	496	200
Total	212,398	71,085

Source: Pennsylvania Statistical Abstract 1976. Department of Commerce, Commonwealth of Pennsylvania.

1990, of which about 176,000 will be passenger cars; and about 79,000 vehicles in Crawford County, of which about 54,000 will be passenger cars.

Highway Passenger and Freight Service Facilities

2.416
Passenger facilities for the Pennsylvania Regional Study Area are shown in Figure 2-45 and bus characteristics are summarized in Table 2-242. The city of Erie has a local bus service provided by the Erie Metropolitan Transit Authority; bus service on most routes is at 30-minute intervals during the peak hours, slightly greater intervals during off-peak hours, and hourly at night. Erie City also has two taxi companies. One provides passenger, baggage, and parcel service within the Erie City and limousine service between Erie International Airport and the city, Wesleyville Borough, Lawrence Park, and Millcreek Townships. The other company provides limousine service between Erie International Airport and hotels and motels within Erie County, as well as to the Pittsburgh Airport during adverse weather or poor airport conditions in Erie. There are 30 trucking firms which have freight terminals in the city of Erie. Figure 2-46 shows freight facilities in the Pennsylvania Regional Study Area.

b) Rail Transportation

2.417
The Regional Study Area is served by three railroads. The largest in terms of trains per day and tonnage carried is the Consolidated Rail Corporation (Conrail). The Conrail main line connects Chicago to New York City via Buffalo and Albany. It runs east to west on double tracks which generally border the southern perimeter of the project site. The Conrail right-of-way in Ashtabula County is 27.6 miles, and 34.5 miles in Erie County. The next largest railroad serving the area is the Norfolk and Western Railway Company (N&W), one of the major profitable railroads serving the eastern and northeastern United States. The main line parallel Conrail less than one mile to the south and is a double-track system. It has the same miles of trackage in the area as Conrail and the main line traversing the Regional Study Area connects Buffalo with Chicago and points west. The third railroad serving the area is the Bessemer and Lake Erie Railroad (B&LE), a Class I common carrier which operates primarily on a north-south route through western Pennsylvania. The railroad extends approximately 140 miles from the southern terminus at North Bessemer, Pennsylvania, to the northern terminus at the Port of Conneaut, Ohio, located on the south shore of Lake Erie. The southern terminus connects with the Union Railroad, also a common carrier, and provides access to the Monongahela River Valley (Pittsburgh Industrial District). The northern terminus at the Port

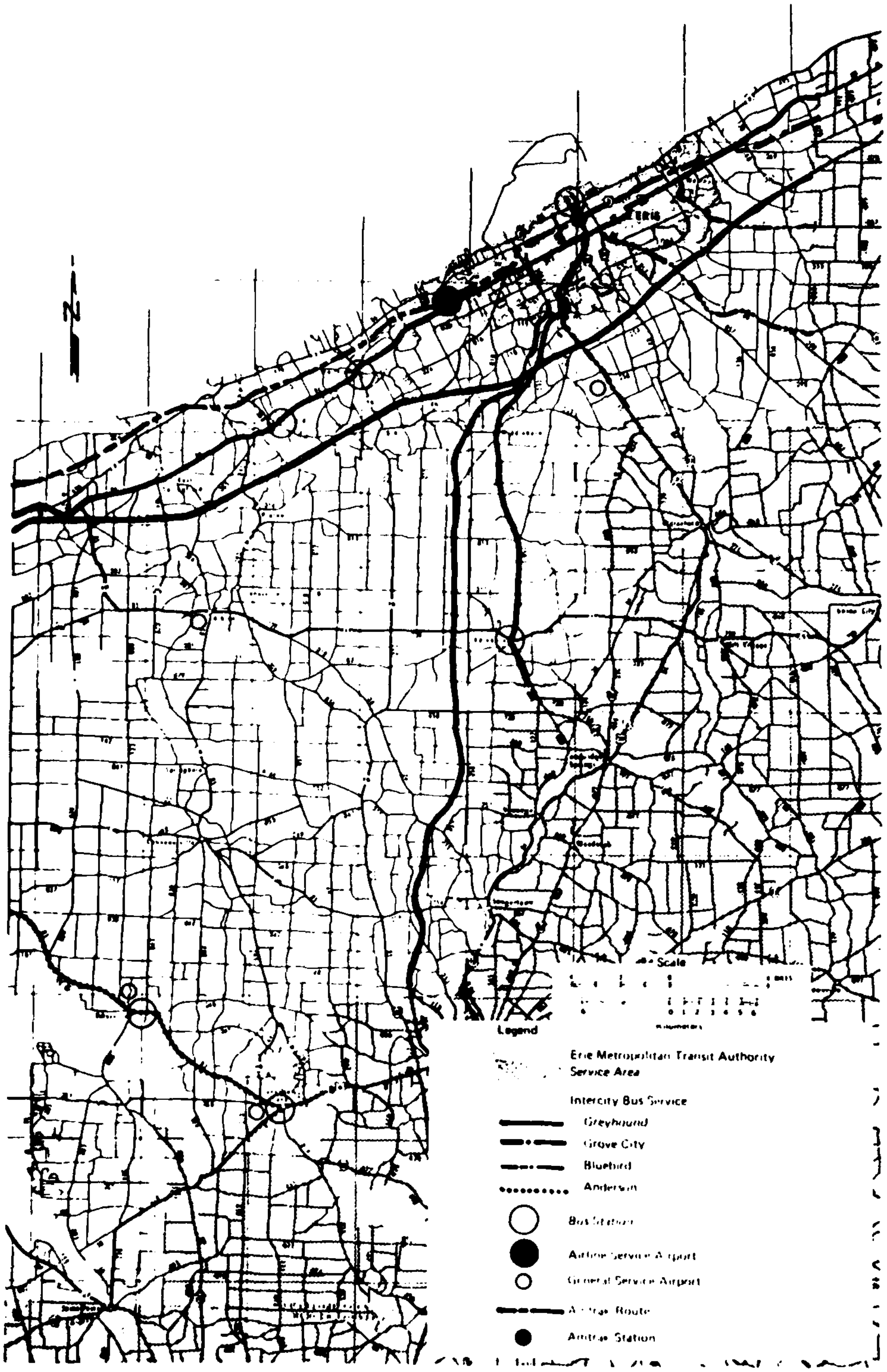

FIGURE 2–45 PASSENGER FACILITIES IN ERIE COUNTY

Table 2-242

Intercity Bus Service Frequency

Destinations	Scheduled Stops at Major Cities	Flag Stops in Study Area	No. of Daily Buses	Remarks
Greyhound				
Erie-Pittsburgh			2	
Erie-Pittsburgh	Edinboro			1 SB Friday 1 NB Friday
Erie-Pittsburgh	Edinboro, Meadville Mercer		1	1 additional SB on Friday and Sunday 1 additional NB on Sunday
Erie-Pittsburgh	Edinboro, Meadville Mercer	Kearsarge, McKean McLane	5	
Erie-Pittsburgh			7	*
Erie-Buffalo	Westfield, Fredonia		4	
Erie-Toronto	Buffalo		2	
Erie-Albany	Buffalo, Rochester Syracuse, Utica		7	Through buses to New York, Boston, and Providence*
Erie-Cleveland			5	*
Erie-Cleveland	Conneaut, Ashtabula Geneva, Painesville	Fairview, Girard	4	
Erie-Chicago	Cleveland, Toledo		3	
Erie-Cincinnati	Cleveland, Columbus		2	*
O.D. Anderson Inc.				
Greenville-Cleveland	Conneaut Lake, Meadville, Linesville, Espyville		2	Friday, Saturday Sunday, Monday only
Grove City Bus Lines				
Erie-Grove City	Waterford, Union City, Titusville, Oil City, Franklin		2	
Blue Bird Coach Lines				
Erie-Mansfield	Union City, Corry, Warren, Kane, Bradford Coudersport, Wellsboro		2	3 days a week
Erie-St. Marys	Waterford, Union City, Warren, Kane			First Sunday of each month only

SB - southbound, NB - northbound

*One bus arrives or departs from Erie-South (I-90 and Pa. 97) without entering the center city.

Source: "Proposed U.S. Steel Plant in Northwest Pennsylvania: Impact Area Profile," Bureau of Advanced Planning, Pennsylvania Department of Transportation, March 1977.

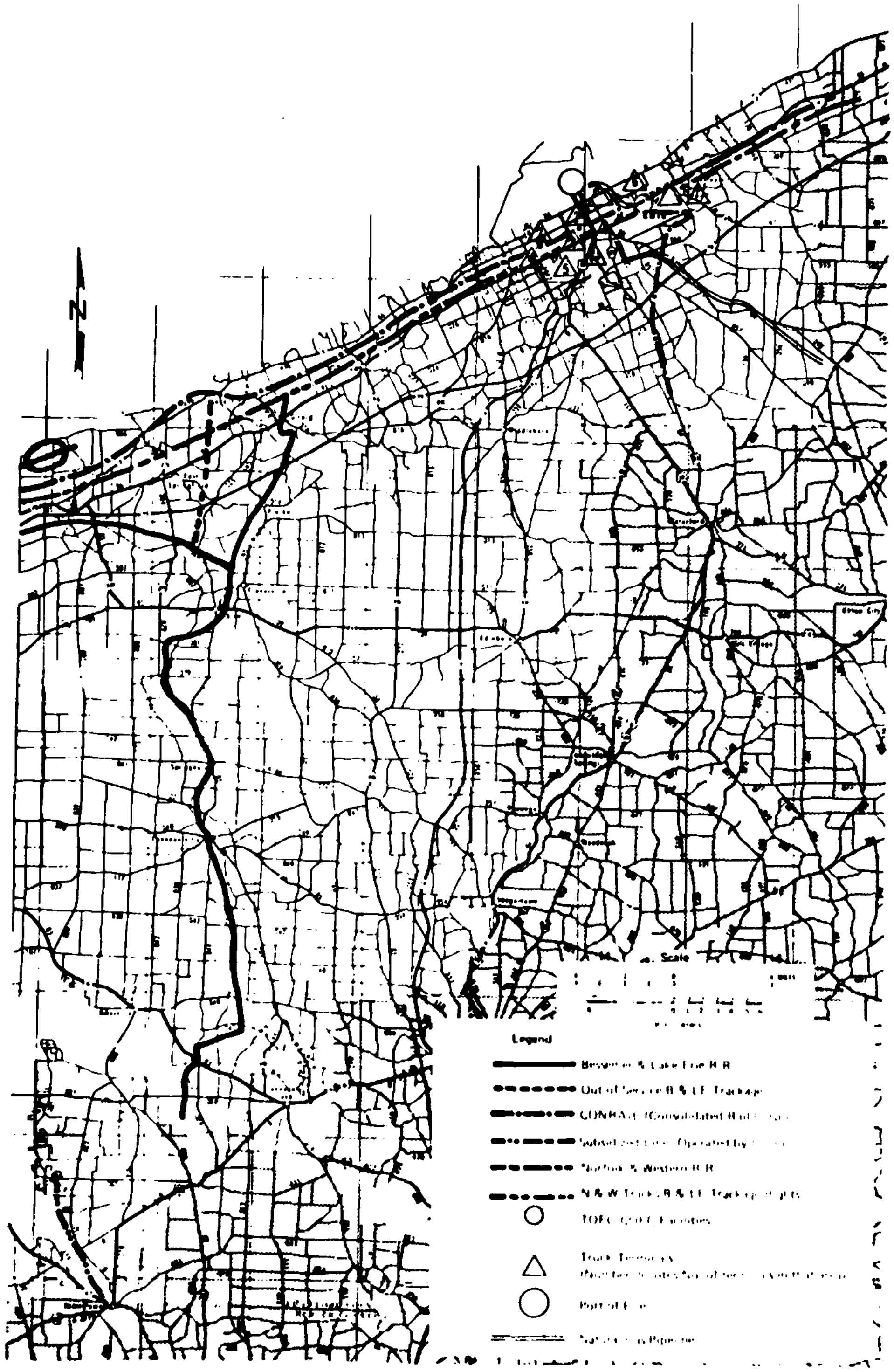

FIGURE 2-46 FREIGHT FACILITIES IN ERIE COUNTY

of Conneaut, Ohio, provides access for transshipment by vessel to the entire Great Lakes area, as well as the St. Lawrence Seaway and all points beyond. Along its line, the B&LE also interchanges with Conrail, the B&O Railroad, and the N&W Railroad. These various interchange points provide additional access to all major industrial areas in the northeast and midwest. The majority of traffic along these routes consists primarily of transporting bulk commodities such as iron ore, coal, and limestone. Of the roughly 250 miles of rights-of-way owned by the B&LE, only a few miles are in Ashtabula County and only 22 miles within the Erie County Study Area.

2.418
The level of railroad activity in Conneaut is listed in Table 2-243. The average tonnage per train varies considerably for each railroad. The considerably lower average tonnage on the Conrail system reflects the effects of both shorter trains and a high percentage of less densely loaded cars than are carried by the N&W and B&LE. Unlike the N&W and the B&LE, Conrail operates a number of branch lines within the Regional Study Area, in addition to its main line trackage described above. In Ashtabula County, these include the following:

- 32 miles of single track from Ashtabula City south to the Trumbull County line;
- 11.6 miles from Carson, which is about four miles south of Ashtabula City, to Jefferson; and
- 14.5 miles from Dorset Junction, which is about 18 miles south of Ashtabula City, to the Pennsylvania line near Jamestown, PA.

In Pennsylvania, Conrail branch lines are located as follows:

- 16.0 miles of the Erie-Warren, PA, line lie in the Erie County portion of the Regional Study Area.

Under the Railroad Revitalization Act of 1973 which set the foundation for the creation of Conrail, a 43.2 mile branch line between North Warren and Ashtabula City and 5.3 miles of the Pymatuning Branch line were not included in the final system plan and were thus abandoned. Under the Railroad Revitalization and Regulatory Reform Act of 1976, the northern 14.9 miles of the north Warren to Ashtabula City branch from Rock Creek to Ashtabula are eligible for Federal subsidy and are so designated according to Ohio's branch line plans. The nature of the assistance is yet to be determined and under this act need not necessarily be subsidized rail service. Assistance could be substituted service by truck or could take the form of industrial relocation assistance. Ohio and Pennsylvania railroads,

Table 2-243

Rail Traffic Through Conneaut in 1977

Railroad	Trains/Day Both Directions	Millions of Tonnes/Year	Average Tonnes Per Train
ConRail	98	99	2768
Norfolk & Western	18	23	3500
Bessemer & Lake Erie	10	15	4109
Total	126	137	

Source: Ohio Department of Transportation; and ConRail, Norfolk & Western Railroad, and Bessemer & Lake Erie Railroad.

Table 2-244

Rail Traffic Through Conneaut in 1990

Railroad	Trains/Day Both Directions	Millions of Tonnes/Year	Average Tonnes Per Train
ConRail	131	132	2768
Norfolk & Western	24	31	3500
Bessemer & Lake Erie	13	20	4109
Total	168	183	

Source: Transportation Projections, 1990, Jack Fawcett, Inc., 1971, for ConRail and Norfolk & Western Railroad; and Bessemer & Lake Erie Railroad.

along with many others in the east, have excess capacity due to decline of traffic since World War II.

2.419
At present, there is very limited rail passenger service in the Regional Study Area. The Amtrak-Chicago Lake Shore Limited passes through the area and stops only in Erie, with its next stop outside the area in Cleveland. There is one train in each direction per day. The westbound train picks up passengers in Erie at 5:25 a.m. and arrives in Cleveland at 7:20 a.m.; eastbound passengers are boarded in Cleveland at 11:15 p.m. and arrive in Erie at 1:17 a.m. There are no current plans to increase rail passenger service. Amtrak, which operates on Conrail trackage, will not initiate new passenger service stops in the Regional Study Area unless there is a guarantee by either a State or a municipal transportation authority to compensate deficits incurred by the new service.

2.420
In addition to the scant likelihood of more frequent passenger service, the high level of freight trains operated by Conrail over this line is not fully compatible with Amtrak's passenger service. High density freight operations are generally at speeds well below the speeds desired by passenger trains and, further, problems of the superiority (i.e. which train has precedence over the other) of passenger trains vs. freight trains cause schedule slippage to either or both. In a study performed for the U.S. Department of Transportation, it was estimated that an annual growth rate of 2.6 percent per year in ton-miles in U.S railroads could be expected through 1990. (2-54) This would indicate a 40 percent increase from 1977 to 1990. In the light of current growth trends, which have decreased slightly since the 1971 forecast, a more conservative estimate of a 33 percent increase has been arbitrarily adopted from now to 1990. Utilizing these data contained in Table 2-243 and assuming car loadings and train lengths will not increase appreciably, forecasts of rail traffic for the year 1990 were derived. The forecasts are presented in Table 2-244. More than sufficient rail capacity exists to accommodate the traffic forecast above. The 131 trains per day forecasted in 1990 for Conrail translate to 2.7 trains per hour in each direction on the average. Assuming a hundred car trains, which would be approximately one mile long and an average speed of only 30 mph and a headway (time between last rail car and locomotive or a trailing train) of five minutes, a single track can handle nine trains per hour or more than three times as many trains as forecasted. The Secretary of Transportation* has designated both the

* Final Standards, Classification and Designation of Lines of Class I Railroads in the United States, Volume II, January 19, 1977. U.S. Dept. of Transportation

N&W and Conrail lines running through the Regional Study Area from east to west in both States as "Corridors of Consolidation Potential." This means that duplicate and therefore excess rail capacity exists in the area and consideration should be given to reducing rights-of-way.

2.421
Currently, the only foreseeable change in the baseline railroad facilities serving the area (other than the continuing possibility of further branch line abandonments) over the projection period is the addition of some loading/unloading trackage within the B&LE coal transshipment area operated by Pittsburgh & Conneaut Dock Company. As noted in the previous section on highway transportation, railroad grade crossings within the downtown area of the city of Conneaut are an undesirable feature from the viewpoint of highway and pedestrian flow within the city as well as from a public safety standpoint when police and other emergency vehicles are delayed. Both bridge and tunnel costs are very large and to date neither of the two railroads (N&W and Conrail) nor the city of Conneaut has allocated funds to correct the situation. Congestion at the rail crossings will probably worsen as the baseline traffic volumes increase.

c) Water Transportation

Port Facilities: Conneaut, Ohio

2.422
The Port of Conneaut is located on the south shore of Lake Erie at the mouth of Conneaut Creek. It is about 120 miles southwest of Buffalo, New York, and about 73 miles northeast of Cleveland, Ohio. The Welland Canal at Port Colborne, Ontario, is 92 miles across Lake Erie in a northeasterly direction from Conneaut. Direct access to the port area from the major highways serving Conneaut is by local streets. The major access highways are U.S. 90, U.S. 20, Ohio State Route 7, Pennsylvania State Route 5 and U.S. 6N. The Conneaut Harbor area consists of an outer harbor sheltered by breakwaters and an inner harbor formed by the lower 3,000 feet of the Conneaut Creek. The harbor is formed by two converging breakwaters and covers about 185 acres of protected water area. The east breakwater is 3,675 feet long with a light at its outer end. The west breakwater is angular in shape and has a total length of 5,938 feet. The 600-foot wide entrance to the harbor is at the northern convergence of the east and west breakwaters. A commercial pier, located on the western shoreline of the harbor, is owned by the city of Conneaut and is operated by the Conneaut Port Authority. It is used primarily by fishing and recreational craft. A small-boat marina lies between this pier and the Conneaut Creek entrance. The outermost portion of the harbor is dredged to a depth of 28 to 29 feet. There is no designated

anchorage area in this outer harbor. The general features of Conneaut Harbor are shown in Figure 2-47.

2.423
The inner harbor area includes the mouth of Conneaut Creek, a turning basin, and four docks (six wharves or berthing areas). The P&C Dock Company owns and operates Dock No. 4, while B&LE owns Docks No. 1, No. 2, and No. 3. Operation of these docks is maintained by Pittsburgh & Conneaut Dock Company for Docks No. 2 and No. 3, while United States Steel Raw Materials Division operates Dock No. 1. The inner harbor docks are utilized as follows (refer to Figure 2-47):

Dock No. 1 Wharf No. 2 - Limestone
Wharf No. 3 - Pig iron and miscellaneous
Wharf No. 4 - Not in use

Dock No. 2 Wharf No. 5 - Vessel mooring and base for tugboats

Dock No. 3 Wharf No. 6 - Coal

Dock No. 4 Wharf No. 7 - Iron ore, pellets, and limestone

The characteristics of the loading and storage areas are shown in Table 2-245. Commodity handling is seldom carried on at Dock No. 2. Dock No. 1 is available for expanded waterborne commerce should future port operations require berth expansion. The shipping season at Conneaut generally extends for a minimum of nine months from 15 March to 15 December, but has been extended to almost year-round operation in recent years.

Port Traffic

2.424
Past and projected baseline commodity traffic at the Port of Conneaut is shown in Table 2-246. This tabulation shows that 90 percent or more of the shipments will be inbound ore and pellets, and outbound coal. Limestone is the only other important commodity passing through the port. The projections show that baseline iron ore traffic will continue to increase through 1990 but will become a smaller percentage of the total commodity traffic, while coal shipments will become a larger percentage of the total commodity traffic. The average movements of ship and train traffic per day in the Port of Conneaut, as projected for 1977 to 1990, are shown in Table 2-247. Raw materials receiving and a shipping forecast prepared by the Pittsburgh and Conneaut Dock Company are shown in Table 2-248. Data on vessel maneuvering, loading and unloading time requirements; vessel traffic; capacity; and dock utilization have been obtained from the P&C Dock Company. These data are summarized below.

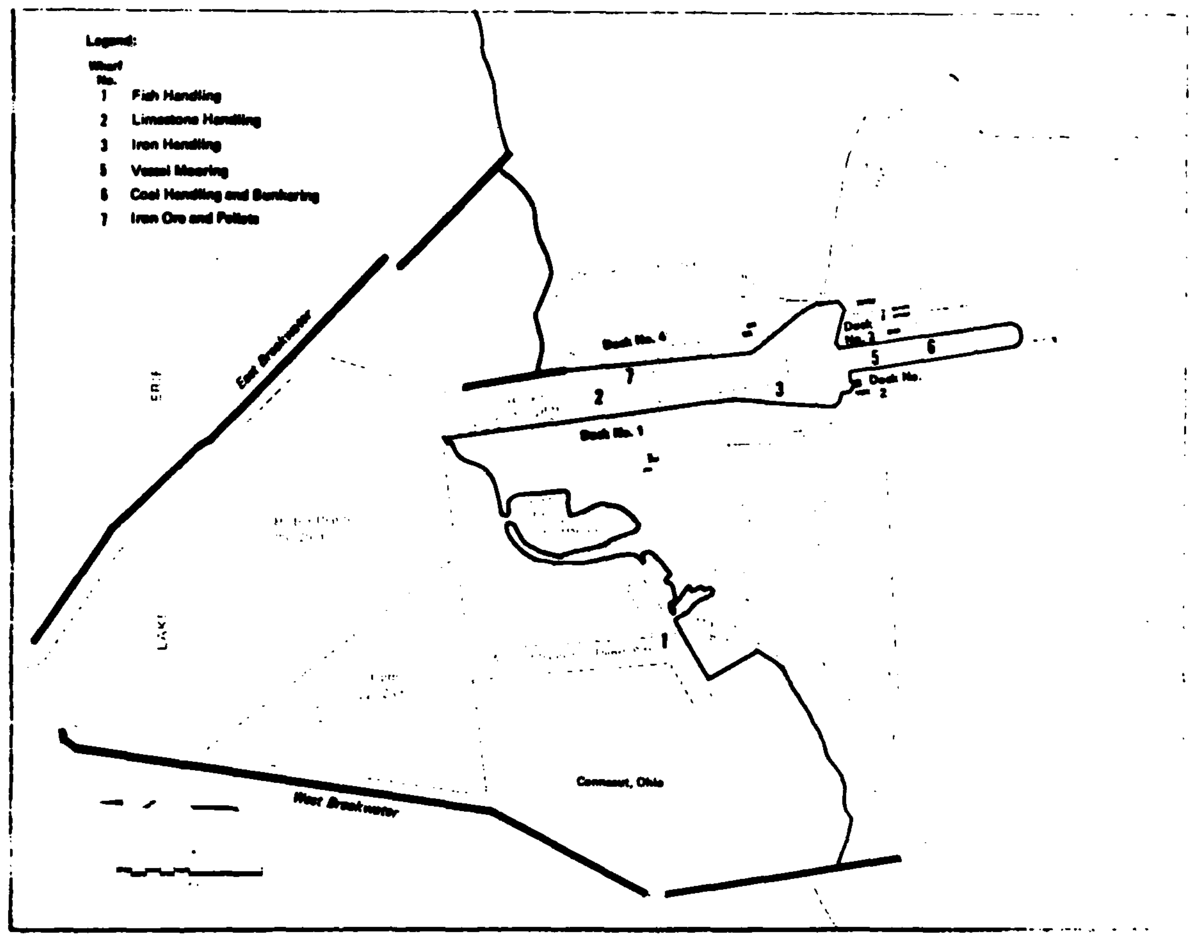

FIGURE 2—47 HARBOR PORT FACILITIES AT CONNEAUT

Table 2-245

Characteristics of Loading and Storage Areas

Commodity	Wharf No.	Max. Handling Rates (Tonnes/Hr)	Storage Area Capacity (Tonnes)
Iron Ore & Pellets	7	9,072 Unload 4,536 Reclaim	2.9×10^6
Limestone	7	2,268 Reclaim	0.54×10^6
Coal	6	9,979 Reclaim and Load	3.2×10^6

Source: Pittsburgh & Conneaut Dock Company.

Table 2-246

Annual Port Commodity Traffic

Commodities	1970 (Actual)(1) Million Tonnes	%	1977(2) Million Tonnes	%	1980(2) Million Tonnes	%	1990(3) Million Tonnes	%
Iron Ore and Pellets (Inbound)	5.373	40%	6.553	43%	10.23	43%	12.90	39%
Limestone (Inbound)	0.875	6	1.43	9	1.70	7	2.51	8
Coal (Outbound)	7.291	54	7.356	48	11.82	50	17.67	53
		100%		100%		100%		100%

Source: (1) Pittsburgh & Conneaut Dock Company.

(2) Pittsburgh & Conneaut Dock Company estimates without the proposed project.

(3) Arthur D. Little, Inc. projection.

Table 2-247

Projected Baseline Figures of Combined Inbound and Outbound Conneaut Port Traffic

(Average Movements per Day)(*)

Mode	1977(1)	1980(1)	1990(2)
Ship	2.56	3.46	4.33
Trains	10.00	14.00	21.00

(*) Seven days per week. Ten months per year for ship movements of pellets, ore, and coal. Nine months per year for limestone. Twelve months for train movement of coal, ore, pellets, and limestone.

Source:

(1) Pittsburgh & Conneaut Dock Company estimates.

(2) Arthur D. Little, Inc. projection, based on increased average ore ship tonnage projected for 1990 by United States Steel Corporation.

Table 2-248

Detail of Raw Material Receiving and Shipment Forecast of The Pittsburgh & Conneaut Dock Company (Proposed Plant Data Not Included)

Raw Materials	Vessel[(a)] Deadweight Min./Max Tonnes	Vessel[(a)] Cargo DWT Min./Max Tonnes	1977 Total No. Vessels	1977 Total Net Tonnes (000)	1980 Total No. Vessels	1980 Total Net Tonnes (000)
Inbound Ships						
Iron Ore/Pellets[(b)]	14,150 45,900	13,800 45,350	279	[illegible],130	[illegible]	[illegible],576
All Other Ores	14,150 28,500	13,800 27,850	47	1,432	[illegible]	[illegible]
Limestone	14,150 32,850	13,800 32,200	52	771	[illegible]	1,225
Outbound Ships						
Metallurgical Coal	8,450 28,500	8,250 27,850	39	785	[illegible]	1,42[illegible]
Steam Coal	8,450 28,500	8,250 27,850	338	6,884	[illegible]32	[illegible],836

(a) Revised 4 May 1977

(b) Maximum ship size for pellets may increase to 60,900 DWT and 59,250 tonnes cargo capacity by 19[illegible].

1. Average number of railroad cars unload/day under conditions (for a 5-day week): 400 - 1977; 640 - 19[illegible].
2. Size of railroad cars (all commodities): Minimum: 54 tonne; Maximum: 91 tonne; Average: [illegible] tonne
3. Size of railroad train (No. of Cars) -

	Minimum	Maximum	Average
Coal	50	130	95
Ore	50	145	100
Limestone	50	130	90

4. Local classification yards (Conneaut & Albion) for rail shipments into the port: Wallace Jct. ([illegible] mi. east of Albion).
5. Length of Minimum Shipping Season:

	Iron Ore	Limestone	Coal
Inbound	10 months	9 months	-
Outbound	-	-	10 months

Approximate running times from light at harbor entrance to tie up:

Dock 4 - Ore	15 minutes
Dock 3 - Coal	25 minutes bow first 45 minutes stern first

Loading times - Coal Dock:

Vessel Class	Length x Beam (Feet)	Range in Size Short Tons*	Loading Time (Hours)**
Maximum	730' x 75'	25-33,000	5 to 7
Large	690' x 70'	22-25,000	8 to 17
Medium	630' x 65'	18-20,000	6 to 14
Small, less than	590' x 60'	8-14,000	5 to 12

* One Short ton is 2,000 pounds; one tonne is 2,204.6 pounds. Coal ships normally are described in short tons. A 25,000-ST ship equals a 22,727-tonne ship, a numerical difference of 9.09 percent.

** Depending on silo condition and type of coal.

Unloading times - Ore Dock:

Vessel Class	Range in Size Length x Beam (Feet)	Long Tons*	4-Huletts (Hours)	5-Huletts (Hours)
Maximum-American	850' x 75'	25-28,000	11	9.5
"AAA"	767' x 70'	26,000	10	8.0
Maximum-Canadian	730' x 75'	25,000	10-12	9-10.5**
"AA"	640' x 67'	18,000	7	5.5
Small, less than	600'	14-15,000	6	4.75
Self-unloaders	1000' (including the Roger Blough)		8	
	730'-770'		7	
	600'		4	

Estimated number of vessels by size, based on 1975-1976 mix of traffic and quoted in percentage of total traffic:

	Percent
1,000-foot type self-unloaders (including the Roger Blough)	9
73,070-foot type self-unloaders	2
600-foot type self-unloaders	3
Maximum size bulkers - American	8
Triple A size bulkers	19
Double size bulkers	14
Maximum size bulkers - Canadian	16
Small size	29
	100

** Depending on type of clean up, grain or coal.

Number of vessels that can be handled at the harbor:

(1) Ore dock can handle (unload) two vessels at one time provided a) one is a self-unloader and one is a bulker; b) proper combination of commodities are on the two vessels; c) proper combination of sizes of the two vessels is available.

(2) Coal dock loads one vessel at a time.

(3) Conneaut Harbor can normally tie up five large vessels at one time.

(1) - Dock Utilization - based on 1976 season, 361 vessels at ore dock:

12-month season

Total hours available (365 x 24)		8,760 hours
Hours to unload	3,886	
Hours to shift vessel	271	
Total time dock occupied		4,157 hours
Percent of time occupied		47 percent

9-month season

Total hours available (30.2 x 9 x 24)		6,523 hours
Hours to unload	3,886	
Hours to shift vessel	271	
Total time dock occupied		4,157 hours
Percent of time occupied		64 percent

(2) - Dock Utilization - based on 1976 season, 288 vessels at coal dock:

12-month season

Total hours available (365 x 24)		8,760 hours
Hours to load	2,298	
Hours to shift vessel	288	
Total time dock occupied		2,586 hours
Percent of time occupied		29.5 percent

9-month season

Total hours available (30.2 x 9 x 24)		6,523 hours
Hours to load vessels	2,298	
Hours to shift vessels	288	
Total time dock occupied		2,586 hours
Percent of time occupied		40 percent

The ore dock calculation assumes that only one berth is used at a time. Both ore and coal calculations use estimated average coal handling and ship maneuvering times as derived from the above.

2.425
The port capacity expressed either in numbers of ships per year or in millions of tonnes per year depends on the mix of ship sizes, ship types, commodity mix, scheduling, weather, and other factors. Obtaining a weighted average which utilizes the data on vessel tonnage, loading or unloading time, and vessel percentage of total traffic, and allowing one hour total to enter and depart the harbor with no other ships maneuvering, a nine-month season would provide a port capacity in the range of 12.0 to 13.0 million tonnes (12.5 to 13.5 million tons) per year for coal and 12.0 to 13.0 million tonnes (12.5 to 13.5 million tons) per year for iron ore and pellets. In the future, larger tonnage vessels probably will be used along with self-unloaders, tighter scheduling may be employed, and the ore dock will be adjusted to accommodate two vessels at least part of the time. Therefore, the upper end of the capacity range seems more likely, without further dock expansion. Facility expansion or augmentation of handling equipment likewise could increase capacity. With a new ore pier expansion three or four ore carriers could unload simultaneously. U.S. Coast Guard ice-breaking capability improvements may extend the shipping season with direct impact on annual tonnage capacity of the port.

New Facilities

2.426
New facilities planned or under construction at the Port of Conneaut independent of the proposed project include additional steam coal storage, together with the necessary railroad switch yard and connecting track and appurtenances. These facilities are currently under construction in the area east of Conneaut Creek. This material handling and storage facility is owned by B&LE Railroad and operated by the Pittsburgh & Conneaut Dock Company for the transshipment of coal. The new facility lies east of Conneaut Creek, north of the Conrail main line tracks and south of the Lake Erie shoreline. It includes 30,000 feet of appurtenant connecting trackage including five load yard tracks, six empty yard tracks, a car thawing shed, car mover, track scale, rotary dumper, dust suppression system, conveyor system, and other equipment and other systems necessary for coal dumping, coal sampling, storage, and reclamation. Construction and track laying operations are presently underway and are expected to be completed and in operation in the Spring of 1978. Department of the Army permits for these additions to the Port of Conneaut were issued to the Bessemer and Lake Erie Railroad and the Pittsburgh and Conneaut Dock Company in 1976. The capacity calculations shown

earlier in this section and the expected 1977 throughputs from Table 2-246 may be compared to provide a measure of current baseline port usage as indicated in the following tabulation:

	Expected 1977 (tonnes x 10^6)	Capacity Range (tonnes x 10^6)
Ore, Pellets and Limestone	8.8	12.0 - 13.0
Coal	8.1	12.0 - 13.0

The Port of Conneaut is operating well below anticipated capacity and is not expected to reach a capacity limit until the end of the 1980 decade.

Port of Ashtabula

2.427
The Port of Ashtabula is located on the south shore of Lake Erie at the mouth of Ashtabula River. It is about 59 miles east of Cleveland, Ohio, and about 134 miles southwest of Buffalo, New York. Major access highways to Ashtabula are Ohio State Route 11, U.S. Rt. 20, Interstate Route 90, and Ohio State Routes 84 and 531. Direct access to the Port is by State Route 11 and local city streets.

The 185-acre outer harbor is protected by a 7,891-foot long west breakwater and a 4,342-foot long east breakwater. Channel depths in soft material are 24 feet from Lake Erie to just inside the breakwater, 28 feet to the inner breakwater, and 27 feet to the Ashtabula River and to the Minnesota Slip. Channel depths are one-foot deeper in hard material. Channel width is generally 1,100 feet. There is a 28-foot deep, 700-foot wide channel from the harbor entrance to the Pinney Dock and Transport Company docks. The turning basin adjacent to the Ashtabula River and Minnesota Slip is 1,200 by 1,500 feet and [illegible] feet deep. The turning basin adjacent to the Pinney Dock and Transport Company docks is 700 by 1,200 feet and is 28 feet deep. The Ashtabula River channel is dredged to a depth of 27 feet to a point 2,000 feet upstream, a depth of 18 feet to the Car Ferry Slip and a depth of 16 feet to the turning basin of the Great Lakes Engineering Works. The navigating season commences about 1 April and closes about 15 December.

2.428
The harbor has 16 piers, wharves and docks of which seven are used for cargo handling and eight for mooring needs, with one not in use. Ten of these facilities are located along the banks of the Ashtabula River, four at the entrance to the Minnesota Slip, and two

at the PD and TC Slip No. 2. There is one wharf for the shipment of coal, one for receiving fresh fish, one for receipt of general cargo, two for receiving iron ore, one for receiving limestone, and one for receiving sand, quartz, limestone, and manganese ore.

Iron ore accounts for more than half the tonnage handled by the Port. The two docks which unload iron ore are the Ashtabula and Buffalo Dock on the west side of the Minnesota Slip and the Union Dock on the east side of the same slip. These docks have a combined capacity of 2,364 feet, a center depth of 226 feet, a combined storage capacity of three million tons, and combined annual tonnage capacity of 24 million tons. Average combined annual tonnage is about seven million tons, handled by four electric Hulletts at each of the docks, with a total combined handling capacity of 4,000 tons per hour. Both of these docks have rail service to South Youngstown and Hubbard, Ohio, and to Pittsburgh, Sharon, Manesson and Aliquippa, Pennsylvania through Conrail and through Norfolk and Western.

Port of Erie

2.429
The Port of Erie is located on the south shore of Lake Erie and is about 98 miles east of Cleveland, Ohio, and about 95 miles southwest of Buffalo, New York. Direct access to the port is through local streets. The city of Erie is accessed by Interstate Routes 90 and 79, U.S. Routes 20 and 19, and State Routes 5, 19, 8, and 430.

Erie Harbor is formed by the curving finger of Presque Isle which extends from the mainland, and is 4.5 miles long by 1.5 miles wide. Harbor entrance piers 360 to 450 feet apart, extend to the 14-foot lake contour. The north pier is 3,248 feet long and the south pier is 2,215 feet long with a 1,200-foot breakwater extending from its inner end toward the mainland. The entrance channel is 29 feet deep and 500 feet wide lakeward of the piers and 28 feet deep and 300 feet wide within the harbor. A harbor basin 28 feet deep and generally 1,500 feet wide extends from the entrance channel to within 50 feet of the U.S. harbor line at the ore terminal. South of this basin is a 27-foot deep approach area to Erie International Marine Terminal No. 1. West of these is another harbor area 21 feet deep, extending westerly 1,200 feet towards the city dock. An additional 18-foot deep, 35-acre harbor area extends still farther west to natural deeper water in the harbor area.

2.430
The ore dock has a capacity of 400,000 tons for iron ore but unloading facilities have been dismantled for several years. There is also a grain dock, sand and stone wharves, and marine terminal which handles general cargo in foreign and domestic trade. The west

dock shares a slip with the ore dock, and there is a public dock used for recreational purposes and for small, private, and commercial boats.

Freight traffic through the port is increasing gradually, from a million tons to more than one and one-half million tons over the last decade, with the major commodities being limestone, sand, gravel, and rock.

d) *Air Transportation*

General

2.431
Only one airport within the Regional Study Area provides regularly scheduled airline service. This is Erie International Airport which is approximately 16 nautical air miles to the east northeast of the proposed plant. The airport is a few miles west northwest of the city of Erie. Both the number of flights and number of cities served from this facility are limited. In 1976, it served five U.S. cities and Toronto with nonstop service and served as a connecting link to New York City, Washington, D.C., and Providence, Rhode Island. Lying outside the Regional Study Area, roughly 70 nautical miles to the west southwest, is Cleveland Hopkins International Airport. In 1975, 2,885,000 air carrier passengers enplaned at this airport contrasted with 125,000 enplanements at Erie International. (2-55) Due to the large number of cities it serves and the frequency of flights it offers, it seems likely that Cleveland (despite its greater distance from Conneaut than Erie) will continue to be the major airport serving the Regional Study Area.

Erie International Airport

2.432
The longest runway at the Erie International Airport is 6,000 feet which is sufficient to handle most short- and medium-haul commercial jet aircraft such as the DC-9, BAC-111, Boeing 727, and Boeing 737. The runway is insufficient for long-haul and jumbo jet aircraft. The airport has instrument approach aids and lighting systems which give it good all-weather use capability. Traffic and operations projected by the Federal Aviation Administration (FAA) through fiscal year 1987 shown in Table 2-249. Also shown are calendar year 1990 forecasts which were made by simple extrapolation assuming that the same growth rate selected by the FAA between FY 82 and 87 would continue through 1990. The FAA anticipates that some type of air taxi service will develop at the airport, although the number of passengers it will handle even by FY 1987 would be only 11 enplaned per day. Operations refer to a landing or a takeoff by an aircraft. To enplane 294,000 passengers in 1990 will require 16,000 air carrier operations. An

Table 2-249

Erie International Airport Activities

Activity	Actual 1975	FY 1979	FY 1982	FY 1987	Calendar 1990(1)
Enplaned passengers (000's)					
Air Carrier	125	159	187	254	294
Air Taxi	0	2	3	4	5
Operations (000's)					
Air Carrier	10	11	13	15	16
Air Taxi	1	1	1	1	1
Itinerant	49	60	72	91	116
Total(2)	80	104	127	153	217

(1) Extrapolated by Arthur D. Little, Inc. using 1982-1987 FAA annual growth rate.

(2) Includes local operations therefore does not total, see text.

Source: "Terminal Area Forecast 1977-1987," FAA-AVP-76-5 Federal Aviation Administration, January, 1976.

estimate of the number of passengers on the average an aircraft will carry upon departure from Erie can be derived by dividing one-half the operations into the enplaned passengers (the aircraft has to land to pick up the passengers which counts as an operation). In 1990, an average of 34 passengers from Erie are expected to be aboard each departing air carrier aircraft as compared with 25 in FY 1975. In Table 2-249, general aviation operations are shown in the itinerant line (although some military aircraft will also be included). These aircraft range from single engine aircraft to large corporate jet aircraft. Total operations shown in this table are greater than the sum of air carrier, air taxi and itinerant operations because another class of operations called local operations is not shown separately by the FAA but is included in the totals. A local operation is one that literally stays in the local flying area (usually within 25 miles of the field) and takes off and lands only at the field. An itinerant operation by contrast is a flight either arriving from or departing to another airport. Erie International Airport has the runway capacity to accommodate all the operations forecast for it through 1990 with additional capacity to spare. It will remain restricted to short- and medium-range air carrier aircraft due to current and planned runway lengths. From 1976 to 1980, it is anticipated that $3.8 million will be spent at Erie International Airport for airport improvements according to Pennsylvania DOT. Improvements will include the extension of the main runway by 500 feet to bring it to 6,500 feet ($2.1 million) and terminal, cargo and customs building construction ($1.1 million).

Cleveland-Hopkins Airport

2.433
The largest runway at the Cleveland-Hopkins Airport is 9,000 feet which is sufficient to handle any commercial aircraft on any domestic flight. Runway length would be insufficient for certain transatlantic flights with aircraft at or near maximum gross weight, especially during the hot summer days when longer takeoff distances are required. The airport has an exceptionally high capacity owing to its many runways, instrumentation, and lighting. A forecast of future activity at the airport has been derived from the same FAA document used for the Erie International Airport activity forecast. These data are presented in Table 2-250. The 6.8 million enplanements forecast by 1990 is significant when compared to passenger enplanements (FAA data) for FY 1974. The nation's eighth ranking airport -- Washington-National, D.C. -- had 5.7 million enplanements while seventh ranked Miami had 6.9 million. Therefore, it is likely that Cleveland-Hopkins will continue to be the dominant air carrier airport serving the Regional Study Area, even though it is between one and one-half and two hours drive from the proposed plant.

Table 2-250

Cleveland-Hopkins International Airport Activity Forecasts

Activity	Actual 1975	FY 1979	FY 1982	FY 1987	Calendar 1990[1]
Enplaned passengers (000's)					
Air Carrier	2,885	3,689	4,330	5,881	6,810
Air Taxi	10	21	30	49	60
Operations (000's)					
Air Carrier	124	146	164	192	209
Air Taxi	16	18	21	25	28
Itinerant	206	271	309	358	387
Total[2]	233	298	336	360	374

(1) Extrapolated by Arthur D. Little, Inc. using 1982-1987 FAA annual growth rates.

(2) Includes local operations therefore does not total, see text.

Source: "Terminal Area Forecast 1977-1987," FAA-AVP-76-5 Federal Aviation Administration, January, 1976.

General Aviation Airports

2.434
General aviation airports do not provide regularly scheduled air carrier passenger service. They accommodate aircraft, which vary in size from small one- and two-propeller aircraft capable of using unpaved air strips and usually flown under VFR (Visual Flight Rules) conditions, to large expensive and fully instrumented turbine-powered multi-engine aircraft operated by corporations and charter aircraft companies. There are a number of general aviation airports in the Regional Study Area which can be classified as either paved or unpaved airports. The latter are used almost exclusively for pleasure flying and play a relatively insignificant role in the transportation system of the area. Paved airports can usually accommodate passenger carrying aircraft of the type operated by corporations, air taxi operators, and possibly even commuter airlines (CAB Part 298 Carriers). The closest paved runway airport to Conneaut is Ashtabula County Airport which is a very well-equipped general aviation airport with a 5,200-foot single paved runway. It has a VOR (Very High Frequency Omni Range) instrument approach to permit IFR (Instrument Flight Rules) operations. In addition, it has an excellent runway lighting system. The airport does not have a control tower but voice communications with the Fixed Base Operator are possible to receive current landing information. The airport is approximately 20 nautical air miles west southwest of the proposed plant and has excellent highway access. Fuel servicing for propeller aircraft is available but not for turbine aircraft. Air taxi service is available. Provision for extending the runway to 7,000 feet has been made in the plans of the Ashtabula County Airport Commission along with building a short (3,200 feet) crosswind runway. Traffic data are not available for the airport since there is no control tower to record these data and no special counts have been made. FAA Form 5010's which are "best estimates" of activity provide information for 1974, the most recent year for which estimates are available. Using the FAA Form 5010 information, aircraft operations for Fiscal Year 1987 are shown in Table 2-251. The estimates were derived by applying FAA General Aviation State Growth Factors for Ohio. (2-55) The calender year 1990 estimates were single time extrapolations assuming a continuation of the same growth rates. In 1974, there were 16 based aircraft at the field. In the Ohio portion of the Regional Study Area there are three unsurfaced runways as follows: Conneaut-North Kingsville Village Airport (3,200 turf), Geneva-Harpersfield Township (2,600, turf), and Orwell Township Airport (1,550, turf). There are four private airports within the Pennsylvania portion of the Regional Study Area. These are the Thermal G. Ranch Airport (2,200, turf), Port Albion Airport (2,680, turf), Merry's Pymatuning Airport (2,200, turf), and Conneaut Lakes Airport (1,900, turf). There are slightly more than a dozen aircraft based at all four of these airports.

Table 2-251

Ashtabula County Airport Activity Forecasts

Operations	1974	1987	1990
Local	12,000	24,000	27,000
Itinerant	15,000	36,000	41,000
Total	27,000	60,000	68,000

Source: 1974 Operations from FAA Form 5010 on file with Great Lakes District of FAA; forecast operations as described above.

Energy Supply

a) Electricity

Service

Ohio Regional Study Area

2.435
All communities in Ashtabula County, except six townships in the southeastern part of the County, are served by the Cleveland Electric Illuminating Company (CEI). The townships of Dorset, Richmond, Williamsfield, Andover, Cherry Hill, and Wayne are served by the Ohio Edison Company (OE) (refer to Figure 2-48). CEI furnishes electric service to about 700,000 customers in an area of approximately 1,700 square miles in northeastern Ohio, including greater Cleveland. CEI's headquarters are in Cleveland, Ohio. OE provides electric service to about 800,000 customers in an area of approximately 7,500 square miles in central and northeastern Ohio. Company headquarters are in Akron, Ohio.

Pennsylvania Regional Study Area

2.436
All of Erie County and all of Crawford County except parts of six townships in the southwestern corner are served by the Pennsylvania Electric Company (Penelec). The townships of North and South Shenango, West Fallowfield and parts of Pine, Summit, and Sadsbury Townships are served by the Pennsylvania Power Company (PPC) a subsidiary of the Ohio Edison Company (refer to Figure 2-48). Penelec furnishes electric service to about 475,000 customers in an area of approximately 15,000 square miles in the northern tier and west central portion of Pennsylvania. Its headquarters are in Johnstown, Pennsylvania. Pennsylvania Power Company (wholly owned by the Ohio Edison Company) provides electric service to 116,000 customers in an area of approximately 1,500 square miles in western Pennsylvania. Its headquarters are in New Castle, Pennsylvania.

Electric Generation*

Ohio Regional Study Area

2.437
Cleveland Electric Illuminating Company. The electric generating facilities of CEI include five fossil fuel plants (primarily coal

* All forecasts of electric power demand and requirements are those prepared by Central Area Power Coordination Group (CAPCO) and its member companies.

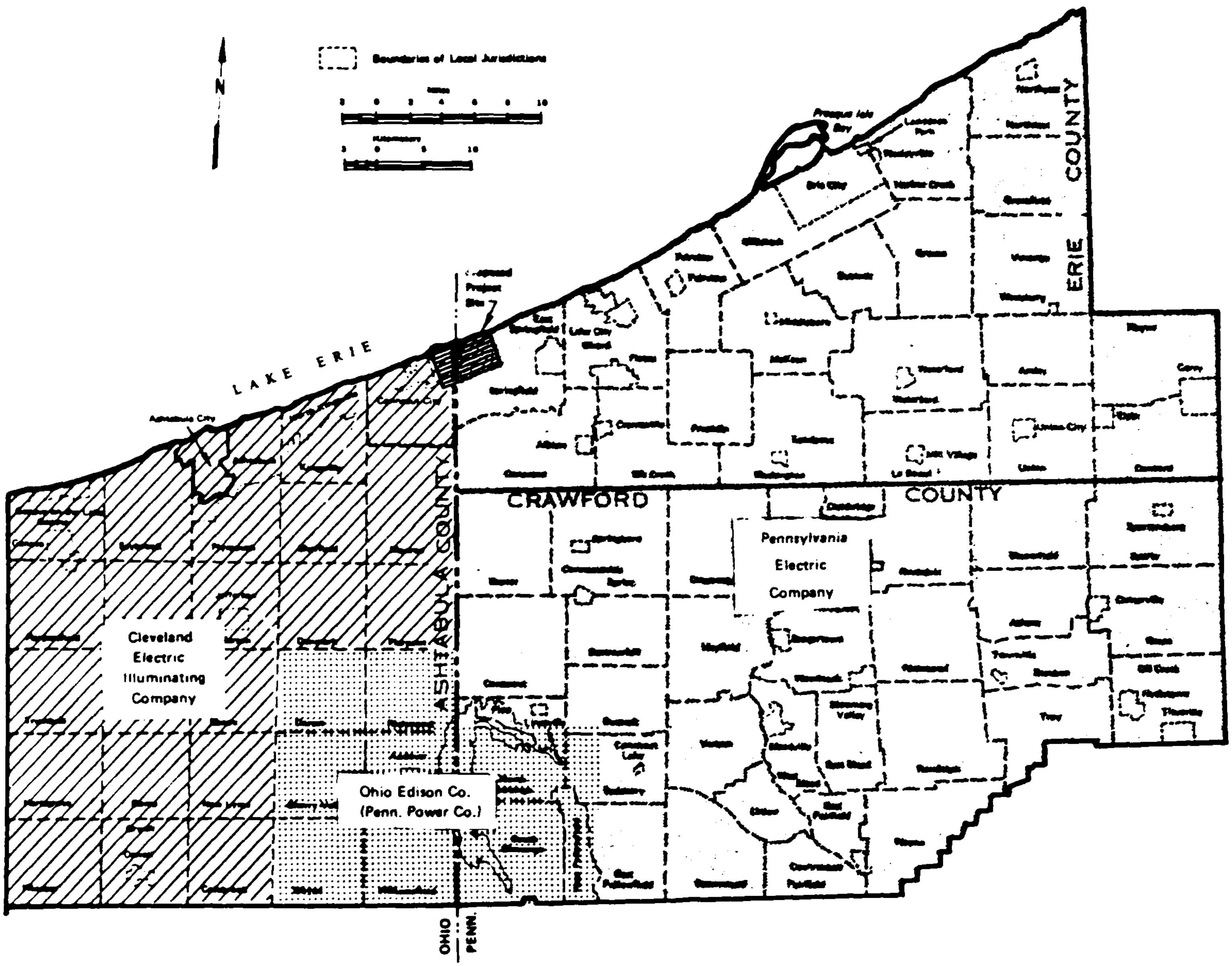

FIGURE 2—48 ELECTRIC UTILITY SERVICE AREAS IN THE REGIONAL STUDY AREA

with diesel and gas turbine peaking units) and the company's share of a pumped-storage hydroelectric plant in Pennsylvania. Collectively, these six plants currently provide CEI with a net system nameplate capability of approximately 4,000 megawatts. A list of the power generating facilities within CEI and its interconnection capability are shown in Table 2-252. The operating characteristics of the CEI electric system for historical and projected periods are summarized in Table 2-253. Average demand grew at an annual rate of 3.6 percent between 1970 and 1976, and it is projected to increase at a growth rate of slightly over four percent per year through 1988. Over the period 1976-1988, generation capability is forecast to grow at an annual rate slightly over 4.5 percent.

2.438
Ohio Edison Company (OE). The electric generating facilities of OE include nine fossil fuel plants (coal with diesel and gas turbine peaking units), one combination turbine plant and one diesel plant. These eleven plants currently provide OE a net system nameplate capability (excluding Pennsylvania Power Company) of approximately 3,700 megawatts. Including the PPC facilities and the new mansfield Unit Number 1, the Ohio Edison System has a capability of over 4,800 megawatts. A list of the power generating facilities operated by Ohio Edison and its interconnection capability with other utilities is presented in Table 2-254. The operating characteristics of the electric system for historical and projected periods is shown in Table 2-255. Average demand grew at an annual rate of 3.7 percent between 1970 and 1976. It is projected to increase at a growth rate of slightly over 5.5 percent over the period 1976-1988. Generation capability is projected to grow at a rate of somewhat over 4.5 percent in the same projection period.

Pennsylvania Regional Study Area

2.439
Pennsylvania Electric Company. The electric generating facilities of Penelec include seven fossil plants (coal with diesel and gas turbine peaking units), part of a nuclear plant, part of a pumped storage plant, four hydroelectric plants, three combination turbine plants, and one diesel plant. These plants currently provide Penelec with a net system capability of over 2,000 megawatts. The generating facilities and interconnection capability of Penelec is summarized in Table 2-256. The operating characteristics of the electric system over historical and projected periods is shown in Table 2-257. Average demand grew at an annual rate of approximately 3.9 percent between 1971 and 1976, and is projected to increase at the same rate over the 1976-1985 period. During 1971-1976, generation capability grew at a rate of 3.2 percent per year. Penelec's capital improvement program is concentrated on the continued construction of Homer

Table 2-252

Generation and Interconnection Capability - -
Cleveland Electric Illuminating Company

Generating Plants

		Capability (kW)		Fuel Type
Ashtabula	Total	640,000		Steam Turbine
Unit 1		50,000		Oil
2		50,000		Oil
3		50,000		Oil
4		50,000		Oil
5		286,000		Coal
6		46,000		Coal
7		46,000		Coal
8		46,000		Coal
9		46,000		Coal
Avon Lake	Total	1,275,000	(excluding combined turbine)	Steam Turbine
Unit 1		35,000		Oil
2		75,000		Oil
3		35,000		Oil
4		35,000		Oil
5		50,000		Oil
6		86,700		Coal
7		86,000		Coal
8		233,000		Coal
9		680,000		Coal
Combined Turbine		32,000		Gas Turbine
East Lake	Total	1,045,000	(excluding combined turbine)	Steam Turbine
Unit 1		123,000		Coal
2		123,000		Coal
3		123,000		Coal
4		208,000		Coal
5		447,000(1)		Coal
Combined Turbine		32,000		Gas Turbine

Table 2-252 (Continued)

Generating Plants

Capability (kW)

Lake Shore	Total	518,000	(excluding diesel)	Steam Turbine
Unit 14		60,000		Coal[2]
15		60,000		Coal[2]
16		69,000		Coal[2]
17		69,000		Coal[2]
18		256,000		Coal[2]
Diesel		4,000		Diesel
Seneca Pumped Storage (Warren, Pa.)	Total	422,100[3]		Turbine
Unit 1		198,000		Turbine
2		198,000		Turbine
3		26,100		Turbine

Major Interconnections

Interconnections with	Max. Tie KVA	Tie Voltages, KV
Ohio Edison Company	445,000	132
Ohio Power Company	682,000	345
Penna Electric Co.	315,000	345
Ohio Edison Company	1,364,000	345

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(1) Unit 5 jointly owned by CEI (68.8%) and Duquesne Light Company (31.2%). Capability shown represents CEI share only.

(2) Unit is planned to be converted to oil in 1977.

(3) Plant jointly owned by CEI (80%) and Pennsylvania Electric Company (20%). Capability shown represents CEI share only.

Source: Electrical World Directory of Electric Utilities, McGraw-Hill Publications, 1976.

Table 2-253

Operating Characteristics -- Cleveland Electric Illuminating Company

Year	Capability (MW)	Peak Demand[1] MW	Peak Demand[1] Percent of Capability	Average Demand[2] MW	Average Demand[2] Percent of Capability	Load Factor[3]
1965	2,255	1,883	84%	1,250	55%	66
1970	3,235	2,517	78	1,689	52	67
1971	3,400	2,750	81	1,725	51	63
1972	3,775	2,822	75	1,833	49	65
1973	3,769	3,119	83	2,084	55	67
1974	3,764	2,934	78	2,034	54	69
1975	3,615	2,937	81	1,972	55	67
1976	3,906	3,065	79	2,087	53	68
	Projected[4]			Projected[5]		
1978	4,600			2,200		
1980	4,800			2,500		
1984	5,600			3,200		
1988	6,700			3,400		

(1) Annual net 60-min. maximum load excluding interruptibles.

(2) Net generation available for service area (produced by utility and imported from elsewhere) divided by total hours in year.

(3) Average demand as a percent of peak demand.

(4) Estimated by applying CAPCO schedule (see Table 2-258). Capability may be higher than nameplate capacity due to entitlements to buy capability.

(5) Approximated from CEI estimates submitted to Ohio Power Siting Commission, 1977.

Source: Cleveland Electric Illuminating Company Annual Reports; Arthur D. Little, Inc. estimates.

Table 2-254

Generation and Interconnection Capability -- Ohio Edison Company

(Excluding Pennsylvania Power Company Capability)

Generating Plants

	Capability (kW)	Fuel Type
W. H. Sammis	1,979,540 (excl. Diesel)	Steam Turbine
Unit 1	185,000	Coal
2	185,000	Coal
3	185,000	Coal
4	185,000	Coal
5	317,500	Coal
6	623,000	Coal
7	299,040 (1)	Coal
Diesel	10,700 (2)	Diesel
R. E. Burger	544,000 (excl. Diesel)	Steam Turbine
Unit 1	62,500	Coal
2	62,500	Coal
3	100,000	Coal
4	159,500	Coal
5	159,500	Coal
Diesel	6,420 (3)	Diesel
Niles	250,000 (excl. C.T.)	Steam Turbine
Unit 1	125,000	Coal
2	125,000	Coal
Comb. Turbine	29,960 (4)	Gas Turbine
Edgewater	192,870 (excl. C.T.)	Steam Turbine
Unit 2	25,000	Coal
3	62,820	Coal
4	105,000	Coal
Comb. Turbine	50,100 (5)	Gas Turbine
Toronto	175,570	Steam Turbine
Unit 5	43,750	Coal
6	66,000	Coal
7	66,000	Coal

Table 2-254 (Continued)

	Capability (kW)	Fuel Type
Mad River	75,000 (excl. C.T.)	Steam Turbine
Unit 1	25,000	Coal
2	25,000	Coal
3	25,000	Coal
Comb. Turbine	59,920 (6)	Gas Turbine
W. Lorain	200,000 (excl. S.T.) (7)	Comb. Turbine
Gas Turbine	118,400	Gas Turbine
Steam Turbine	81,600	Coal
Gorge	87,500	Steam Turbine
Unit 6	43,750	Coal
7	43,750	Coal
Norwalk	32,328 (excl. Diesel)	Steam Turbine
Unit 1	1,500	Coal
2	2,500	Coal
3	3,000	Coal
4	6,000	Coal
5	18,328	Coal
Diesel	1,000	Diesel
East Palestine	16,500	Steam Turbine
Unit 1	2,500	Coal
2	1,500	Coal
3	5,000	Coal
4	7,500	Coal
New Castle	3,300 (8)	Diesel
Diesel 1	1,650	Diesel
Diesel 2	1,650	Diesel

Table 2-254 (Continued)

Major Interconnections

Interconnection With	Tie Voltage, kV
Cleveland Electric Illuminating Company	138 and 345
Columbus & Southern Ohio Electric Company	138
Ohio Power Company	69, 138 and 345
Toledo Edison Company	138
Dayton Power & Light Company	69 and 138
Monougahela Power Company	345
Duquesne Light Company	345

Notes: Capability shown for jointly owned units represents OE share only.

(1) W. H. Sammis unit 7 jointly owned by OE (48.2%), Pennsylvania Power Co. (PPL) (20.8%) and Duquesne Light Co. (DLC) (31.2%).

(2) W. H. Sammis Diesels jointly owned by OE (85.6%) and PPC (14.4%).

(3) R. E. Burger Diesels jointly owned by OE (85.6%) and PPC (14.4%).

(4) Niles Comb. Turbine jointly owned by OE (85.6%) and PPC (14.4%).

(5) Edgewater Comb. Turbine jointly owned by OE (86.0%) and PPC (14.0%).

(6) Mad River Comb. Turbine jointly owned by OE (85.6%) and PPC (14.4%).

(7) W. Lorain Comb. Turbine jointly owned by OE (85.0%) and PPC (15.0%).

(8) New Castle Diesels jointly owned by OE (60.0%) and PPC (40.0%).

Source: Electrical World Directory of Electric Utilities, McGraw-Hill Publications, 1976; Financial Data and Statistics, Ohio Edison Company, 1975.

Table 2-255

Operating Characteristics
Ohio Edison Company
(Including Pennsylvania Power Company)

Year	Capability (MW)	Peak Demand[1] MW	Peak Demand[1] Percent of Capability	Average Demand[2] MW	Average Demand[2] Percent of Capability	Load Factor[3]
1965		2,281		1,568		69
1970		3,053		2,120		69
1971		3,307		2,207		67
1972		3,530		2,391		68
1973		3,810		2,558		67
1974		3,664		2,544		69
1975	4,374	3,682	84	2,465[5]	56	67
1976	5,353	3,865	72	2,641	49	68
	Projected[4]			Projected[5]		
1978	5,750			2,946		
1980	6,100			3,399		
1984	7,500			4,178		
1988	9,250			5,099		

(1) Annual net 60 min. maximum load.

(2) Net generation available for service area (generation after station loss and use plus net purchased and interchanged energy plus power generated during construction) divided by total hours in year.

(3) *Average demand as a percent of peak demand.*

(4) Estimated by applying CAPCO schedule (see Table 2-[illegible]). Capability can be higher than capacity due to entitlements to buy capability.

(5) Approximated from OE estimates submitted to Ohio Power Siting Commission for Ohio demand, 1977. Assumed that Pennsylvania Power Company accounts for 15% of OE system demand.

Source: Financial Data and Statistics, Ohio Edison Company, 197[illegible]; Ohio Edison Company 197[illegible] Annual Report; Arthur D. Little, Inc. estimates.

Table 2-256

Generation and Interconnection Capability -- Pennsylvania Electric Company

Generating Plants

	Capability (kW)	Fuel Type
Shawville	640,000 (excluding diesel)	Steam Turbine
Unit 1	132,500	Coal
2	132,500	"
3	187,500	"
4	187,500	"
5	2,000	Diesel
6	2,000	"
7	2,000	"
Seward	268,200	Steam Turbine
Unit 2	27,000	Coal
3	35,000	Coal
4	50,000	Coal
Warren	84,600	Steam Turbine
Unit 1	42,300	Coal
2	42,300	Coal
Front Street	118,800	Steam Turbine
Unit 1	18,000	Coal
2	10,000	Coal
3	15,000	Coal
4	25,000	Coal
5	50,000	Coal
Williamsburg	25,000	Steam Turbine
Unit 5	25,000	Coal
Homer City	660,000 (excluding diesel)	Steam Turbine
Unit 1	330,000	Coal
2	330,000	Coal
Diesel	1,000	Diesel

Table 2-256 (Continued)

	Capability (kW)	Fuel Type
Benton	4,000	Diesel
Unit 1	2,000	Diesel
2	2,000	Diesel
Blessburg	23,600	Gas Turbine
Unit 1	23,600	Gas Turbine
Warren	53,100	Comb. Turbine
Unit 3	53,100	Diesel
Wayne	53,100	Comb. Turbine
Unit A	53,100	Diesel
Deep Creek	19,200	Hydro-Turbine
Unit 1	9,600	Hydro
2	9,600	Hydro
Piney	28,800	Hydro-Turbine
Unit 1	9,600	Hydro
2	9,600	Hydro
3	9,600	Hydro
Warrior Ridge	2,000	Hydro-Turbine
Unit 3	500	Hydro
4	500	Hydro
5	500	Hydro
6	500	Hydro
Oakland	600	Hydro-Turbine
Unit 1	600	Hydro
Seneca	84,400(1)	Pumped Storage
Unit 1	39,600	Hydro
2	39,600	Hydro
3	5,200	Hydro
Three Mile Island	217,700(2)	Steam Turbine
Unit 1	217,700	Nuclear

Table 2-256 (Continued)

Major Interconnections

Interconnections With	Max Tie kVA	Tie Voltage, kV
Metropolitan Edison Company	75	115
	44	230
Niagara Mohawk Company	480	230
	83	115
Pennsylvania Power & Light Company	86	115
	427	230
	12	230
	478	230
New York State Electric & Gas Company	444	220
	106	115
	90	115
	715	345
West Pennsylvania Power Company	147	115
	22	138
	120	138
	336	230
	224	230
Potomac Electric Company	90	138
	57	115
Cleveland Electric Illuminating Company	1004	345
Keystone	[illegible]	[illegible]
[illegible]maugh	[illegible]	[illegible]

(1) Represents Penelec's Interest [illegible]

(2) Represents Penelec's Interest, [illegible]

Source: Electrical World Directory [illegible] Publications, 19[illegible].

Table 2-257

Operating Characteristics -- Pennsylvania Electric Company

Year	Capability (MW)	Peak Demand[1] MW	Peak Demand[1] Percent of Capability	Average Demand[2] MW	Average Demand[2] Percent of Capability	Load Factor[3]
1972	2036	1694	83	1267	62	66
1973	1977	1790	91	1207	61	66
1974	2157	1766	82	1192	55	68
1975	2157	1880	87	1178	55	64
1976	2172	1994	92	1118	51	64
	Projected[4]			Projected[4]		
1978	2030			1238		
1980	2215			1357		
1984	2640			1625		
1988	3147			1951		

(1) Annual hourly peak load.

(2) Net generation available for service area (generation after station loss and use plus net purchased and interchanged) divided by total hours in year.

(3) Average demand as a percent of peak demand.

(4) Estimated on the basis of Penelec submission to Pa. PUC.

Source: Pennsylvania Electric Company, 1976 Annual Report; Penn. Electric Company Power System Statement Schedule II, Pa. PUC, April 30, 1976, and Arthur D. Little, Inc. estimates.

City Station Unit No. 3 and Three Mile Island Nuclear Station Unit No. 2, the upgrading of existing generating facilities to meet environmental regulations, and on major efforts to improve the operating efficiency of existing operating units. Electricity generated in the Front Street Plant roughly matches existing requirements in the Pennsylvania Regional Study Area. The net station generation is on the order of 625,000 megawatt-hours. According to the Pennsylvania Public Utilities Commission (PaPUC) any increased demand in the Regional Study Area would be met by transmitted power from Homer City Station, other generating stations in the Penelec system, and imported power from Ohio and New York State. To improve power supply in northwestern Pennsylvania, Penelec is planning a new 800-MW coal-fired plant near Erie. The earliest expected completion date of COHO Unit No. 1 is 1985.

2.440
Pennsylvania Power Company. The electric generating facilities of PPC include two coal plants with diesel peaking capability and part of six Ohio plants. These plants currently provide PPC with a net system capability of about 1,200 megawatts (including the new Mansfield Unit Number 1). The generating facilities and interconnection capability of this company are presented in Table 2-258. PPC is a wholly owned subsidiary of the Ohio Edison Company. Projected capability and requirements are incorporated within the Ohio Edison data shown in Table 2-255. PPC requirements account for approximately 15 percent of the combined OE and PPC systems.

CAPCO Group

2.441
In 1967, five utilities serving northern and central Ohio and western Pennsylvania established the Central Area Power Coordination Group (CAPCO Group) with the express purpose of joint development of large, new generating plants and related transmission facilities. The five utilities are Toledo Edison Company, Ohio Edison Company, Cleveland Electric Illuminating Company, Pennsylvania Power Company, and Duquesne Light Company. Their combined service areas total about 14,000 square miles with a population of about seven million. The CAPCO power pool makes possible greater reliability and lower cost of providing electric service by the pooling of the generating reserves of the five participating utilities, the installation of larger, more efficient electric generating units, the coordination of maintenance and the strengthening of interconnections within the pool. All CAPCO Group utilities are members of the East Central Area Reliability (ECAR) coordination group, which is comprised of 26 electric utilities located in eight contiguous states. ECAR's purpose is to improve reliability of bulk power supply through coordinated planning

Table 2-258

Generation and Interconnection Capabilities -- Pennsylvania Power Company
(Wholly Owned Subsidiary of Ohio Edison Company)

Generating Plants

	Capability (kW)	Fuel Type
New Castle	425,200 (excl. Diesel)	Steam Turbine
Unit 1	42,500	Coal
2	42,500	Coal
3	103,000	Coal
4	105,000	Coal
5	136,800	Coal
Diesel	2,200 [8]	Diesel
W. H. Sammis	131,380 (inc. Diesel)	Steam Turbine
Unit 7	129,580 [1]	Coal
Diesel	1,800 [2]	Diesel
W. Lorain	35,300 (inc. S.T.)	Comb. Turb. & S.T.
C.T.	20,900 [7]	Comb. Turbine
S.T.	14,400	Steam Turbine
Mad River	10,000 [6]	Comb. Turbine
Comb. Turbine	10,080	Gas Turbine
Edgewater	8,150 [5]	Comb. Turbine
Comb. Turbine	8,150	Gas Turbine
Niles	5,040	Comb. Turbine
Comb. Turbine	5,040 [4]	Gas Turbine
R.E. Burger	1,080	Diesel
Diesel	1,080	Diesel
Mansfield	530 [9]	Steam Turbine
Unit 1	530	Coal

Major Interconnections

Interconnection With	Max. Tie kVA	Tie Voltage kV
Duquesne Light Company	40,000	69
	83,000	345
West Pennsylvania Power Company	175,000	138
	9,300	69

Table 2-258 (Continued)

Notes (1) - (8):

Capability shown for jointly owned units demands PPE share only. See notes (2) - (8) in Table 2-254.

Note (9):

Capability shown for Mansfield unit represents OE share which includes PPE.

Source: Electrical World Directory of Electric Utilities, McGraw Hill Publication, 1976; Financial Data and Statistics, Ohio Edison Company, 1975.

and operation of member companies' generation and transmission facilities. The CAPCO Group interconnected system is shown in Figure 2-49. By the end of 1986, the CAPCO Group plans to have completed the construction of fourteen major electric generating units with a total net demonstrated capability of slightly over 13,000 megawatts, together with peaking and other short lead-time units having a net demonstrated capability of nearly 900 megawatts and the necessary interconnecting transmission facilities. The CAPCO Group development schedule is presented in Table 2-259. Each utility in the CAPCO Group will own a portion of one or more of the generating units and will have the right to the net capability and associated energy of (and will be obligated for the capital and operating costs equivalent to) its respective ownership portions. Each utility will then have, for limited periods of time, certain net capability and associated energy entitlements from the portion of these generating units owned by the utilities.

Demand

Ohio Regional Study Area

2.442

Cleveland Electric Illuminating Company. Approximately 10 percent of CEI's total service area deliveries are to wholesale customers for resale and distribution to other miscellaneous customers. Of the electricity distributed for end-use purposes to residential, commercial, and industrial customers (90 percent), approximately 25 percent each is consumed by the residential and commercial customer class and the other 50 percent by industrial customers. The demand characteristics for the CEI system are shown in Table 2-260. Prior to 1973, demand increased at rates approximating the national average (six percent-eight percent). Since then, demand growth rates ranged from - two percent to +two percent annually for each customer class. Demand in the near future may be expected to increase at an annual rate of about 4-4.5 percent. Average customer demand in 1976 was about 6,400 kWhrs per residential customer, and 69,000 kWhrs per commercial customer. Average demand increased at an annual rate of about five percent for each class of service in the 1965-1973 period; but remained roughly constant or declined in the 1973-1976 period. The 1973-1976 period has been a period of adjustment reflecting conservation practice, the effect of higher prices and unstable economic conditions. The average cost of electricity increased at an annual rate of 0.8 percent to 2.2 percent depending on service class between 1965 and 1973 and since 1973 has increased by more than 14 percent per year. In 1976, the average cost of electricity was 3.96 cents per kWh for residential customers, 3.39 for commercial customers, and 2.33 for industrial customers.

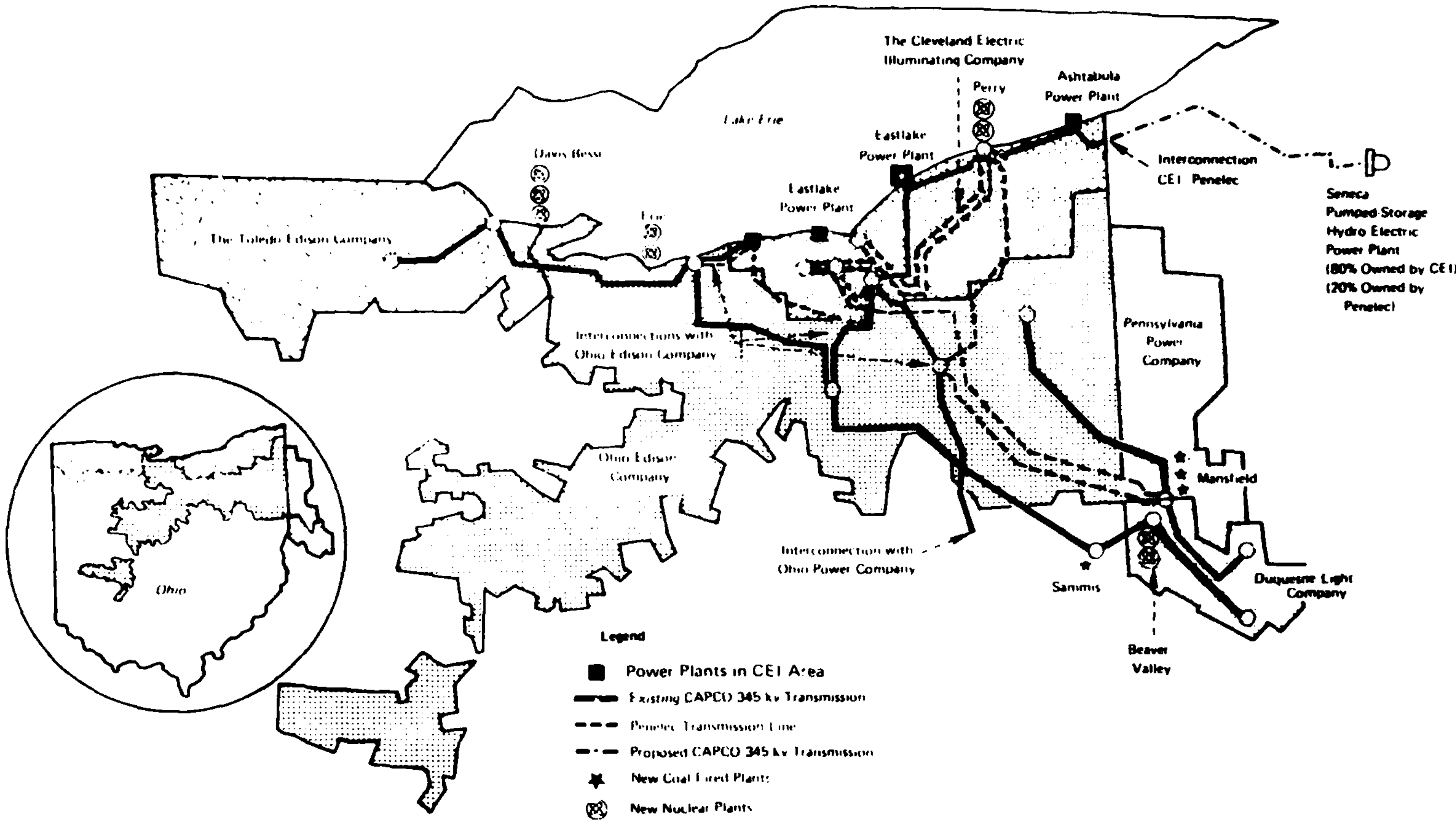

FIGURE 2–49 CAPCO POWER POOL

Table 2-259

CAPCO Group Development Schedule

Project	Fuel Source	Expected Capability (MW)	Scheduled Completion	Responsible Utility[1]
East Lake				
Unit 5	Coal	650	1972	CEI
Sammis				
Unit 7	Coal	650	1976	OE
Perry	Nuclear			
Unit 1		1,205	1981	CEI
2		1,205	1983	CEI
Davis-Besse	Nuclear			
Unit 1		906	1977	TE
2		906	1985	TE
3		906	1987	TE
Mansfield	Coal			
Unit 1		825	1976	PPC
2		825	1977	PPC
3		825	1980	PPC
Beaver Valley	Nuclear			
Unit 1		885	1976	DL
2		885	1982	DL
Erie	Nuclear			
Unit 1		1,260	1986	OE
2		1,260	1988	OE

[1] CEI - Cleveland Electric Illuminating Company
OE - Ohio Edison Company
TE - Toledo Edison Company
PPE - Pennsylvania Power Company
DL - Duquesne Light Company

Source: The Cleveland Electric Illuminating Company Annual Report, 1976; Financial Data and Statistics, Ohio Edison Company, 1976.

Table 2-260

Demand Characteristics -- Cleveland Electric Illuminating Company

	1965	1970	1971	1972	1973	1974	1975	1976	Annual Percent Change 1965/73	1973/76	1965/76
System Customer Demand (Million kWh)											
Residential	2340	3443	3531	3730	3910	3830	3984	4045	6.6%	1.1%	5.1%
Commercial	1955	2984	3144	3356	3569	3527	3685	3809	7.8	2.2	6.3
Industrial	5495	6794	3814	7299	9103	8819	7822	8475	6.5	-2.4	4.0
Other	348	602	576	788	1164	1425	2641	1740	16.3	14.3	15.8
Average Customer Demand (Thousand kWh per Customer)											
Residential	4.2	5.7	5.9	6.1	6.3	6.1	6.4	6.4	5.2	0.5	3.9
Commercial	47.1	60.9	62.5	65.0	68.3	66.5	68.6	69.0	4.8	0.3	3.5
Industrial	851	952	957	1010	1227	1222	1088	1176	4.7	-1.4	3.0
Other	495	1139	1271	1739	2566	3110	5755	3783	22.8	13.8	20.3
Average Cost (Cents per kWh)											
Residential	2.51	2.46	2.64	2.65	2.67	3.66	3.87	3.96	0.8	14.0	4.2
Commercial	2.03	2.09	2.23	2.23	2.26	3.10	3.30	3.39	1.4	14.5	4.8
Industrial	1.11	1.24	1.36	1.37	1.32	2.01	2.31	2.33	2.2	20.9	7.0
Other	1.73	1.69	1.86	1.77	1.53	2.10	2.11	2.63	-1.5	19.8	3.9

Source: Cleveland Electric Illuminating Company Annual Reports, 1970 and 1976.

2.443
Ohio Edison Company. Approximately seven percent of Ohio Edison's deliveries is to wholesale customers for resale and distribution to others. Of the electricity distributed for end-use purposes to residential, commercial, and industrial customers, approximately 31 percent is consumed by residential customers, 22 percent by commercial customers, and 47 percent by industrial customers. The demand characteristics for the Ohio Edison system are illustrated in Table 2-261. Demand increased at about seven percent per year betwen 1965 and 1973. However, from 1973 and 1976 demand growth rates declined about 50 percent. Future demand may increase at a rate of about five-six percent per year based on utility company projections. Average customer demand in 1976 was about 7,300 kWhrs per residential customer and 51,000 kWhr per commercial customer. Between 1965 and 1973 average demand increased at an annual rate of 5.5 percent and 7.1 percent while in 1973 and 1976 the increase averaged 1.9 percent and 1.1 percent, respectively. The 1973-1976 period is a period of adjustment following the 1972-1973 "energy crisis." Average cost of electricity barely increased between 1965 and 1973 for residential and commercial customers while industrial customers experienced an increase of 2.3 percent during the same period. Average cost increased at a rate of over 13 percent annually after 1973. In 1976, the average cost of electricity was 3.9 cents per kWh for residential customers, 3.6 and 2.1 cents per kWh for commercial and industrial customers, respectively.

Pennsylvania Regional Study Area

2.444
Approximately seven percent of Penelec's deliveries is electricity to wholesale customers for resale and distribution. Of the electricity distributed for end-use purposes to residential, commercial and industrial customers, approximately 31 percent is consumed by residential customers, 22 percent by commercial customers, and 47 percent by industrial customers. The demand characteristics for the Penelec system are shown in Table 2-262. Since 1973, residential demand has increased by 3.1 percent per year, commercial demand by 3.6 percent, and industrial demand by 1.1 percent. Demand in the near future may be expected to increase at a 4-5 percent annual rate. Average customer demand in 1976 was about 6,800 kWh per residential customer. Average consumption increased by 1.5 percent per year between 1973 and 1976. Average cost of electricity increased at an annual rate of approximately 11 percent between 1973 and 1976 for residential and commercial customers and 16 percent for industrial customers. In 1976 the average cost of electricity was 4.1 cents per kWh for residential customers and 3.8 and 2.5 cents per kWh for commercial and industrial customers, respectively.

Table 2-261

Demand Characteristics -- Ohio Edison Company

(Including Pennsylvania Power Company)

	1965	1970	1971	1972	1973	1974	1975	1976	Annual Percent Change 1965/73	1973/76	1965/76
System Customer Demand (Million kWh)											
Residential	2988	4383	4656	5023	5390	5610	5809	6024	7.7%	3.8%	6.6%
Commercial	1957	3187	3421	3692	4036	4023	4169	4358	9.5	2.6	7.5
Industrial	6961	8150	8548	9250	9863	9630	8514	9262	4.5	-2.1	2.6
Other	756	1366	1193	1307	1384	1419	1489	1558	7.9	4.0	6.8
Average Customer Demand (Thousand kWh per Customer)											
Residential	4.5	6.1	6.4	6.7	6.9	7.1	7.2	7.3	5.5	1.9	4.5
Commercial	28.5	42.2	44.3	46.6	49.3	48.6	49.7	51.0	7.1	1.1	5.4
Industrial	6825	7546	7814	8193	8744	8683	7521	8336	3.1	-1.6	1.8
Average Cost (cents per kWh)											
Residential	2.64	2.39	2.45	2.49	2.62	3.20	3.81	3.86	0.0	14.5	3.8
Commercial	2.46	2.25	2.33	2.38	2.46	3.03	3.58	3.57	0.0	12.9	3.4
Industrial	0.98	1.02	1.08	1.10	1.17	1.66	2.12	2.11	2.3	20.1	7.0
Other	1.30	1.20	1.29	1.34	1.47	1.90	2.25	2.42	1.8	17.0	5.7

Source: Financial Data and Statistics and Annual Report; Ohio Edison Company, 1976.

Table 2-262

Demand Characteristics -- Pennsylvania Electric Company

	1972	1973	1974	1975	1976	Annual Percent Change 1973/76
System Demand (Million kWh)						
Residential	2577	2682	2726	2796	2935	3.1%
Commercial	1729	1868	1833	1964	2079	3.6
Industrial	3849	4203	4328	4237	4340	1.1
Other	660	633	646	589	705	3.7
Average Customer Demand (Thousand kWh per Customer)						
Residential	6.4	6.5	6.5	6.6	6.8	1.5
Average Cost (Cents per kWh)						
Residential	2.84	3.01	3.44	4.01	4.10	11.0
Commercial	2.63	2.81	3.23	3.71	3.81	10.7
Industrial	1.51	1.63	1.95	2.39	2.48	16.0
Other	1.27	1.44	2.07	2.49	2.90	27.5

Source: Pennsylvania Electric Company Annual Report, 1976.

b) Natural Gas

Service

Ohio Regional Study Area

2.445
The Coastal Communities of Ashtabula County are served by the East Ohio Gas Company (EOG) (a wholly owned gas distribution subsidiary of Consolidated Natural Gas Company). The EOG serves the cities of Ashtabula, Conneaut, and Jefferson, Ohio, as well as the Coastal Communities north of Interstate 90. The rest of Ashtabula County (with the exception of Andover and Williamsfield townships, which are served by the United Natural Gas Company) is not served by a natural gas utility. EOG furnishes gas service to nearly 975,000 customers in the greater Cleveland area. The Company's headquarters are in Cleveland, Ohio. Gas distribution systems in the Ohio Regional Study Area are shown in Figure 2-50.

Pennsylvania Regional Study Area

2.446
All of Erie County and approximately half of Crawford County are served by the National Fuel Gas Distribution Corporation (NFG) (a wholly-owned public utility subsidiary of National Fuel Gas Company). The western half of Crawford County is generally supplied with natural gas, while most of the rural eastern half is not provided with gas service (refer to Figure 2-50). NFG furnishes gas service to over 650,000 customers in more than 450 communities with an estimated population of nearly 2.5 million in western New York, northwestern Pennsylvania, and a small area in eastern Ohio. The Company's headquarters are in Buffalo, New York. An administrative office is located in Erie, Pennsylvania, which serves as headquarters for the Pennsylvania portion of the system.

Supply System

Ohio Regional Study Area

2.447
The East Ohio Gas Company distribution system is part of the Consolidated Natural Gas System (CNG). The CNG system is an integrated gas system dependent primarily on southwest pipeline gas supply. The principal communities served by the system are Cleveland, Youngstown, Akron, and Lima, Ohio; Pittsburgh and Johnstown, Pennsylvania; and Clarksburg and Parkersburg, West Virginia. The CNG system encompasses five distribution companies serving about 1.5 million customers. Until recently, CNG relied on

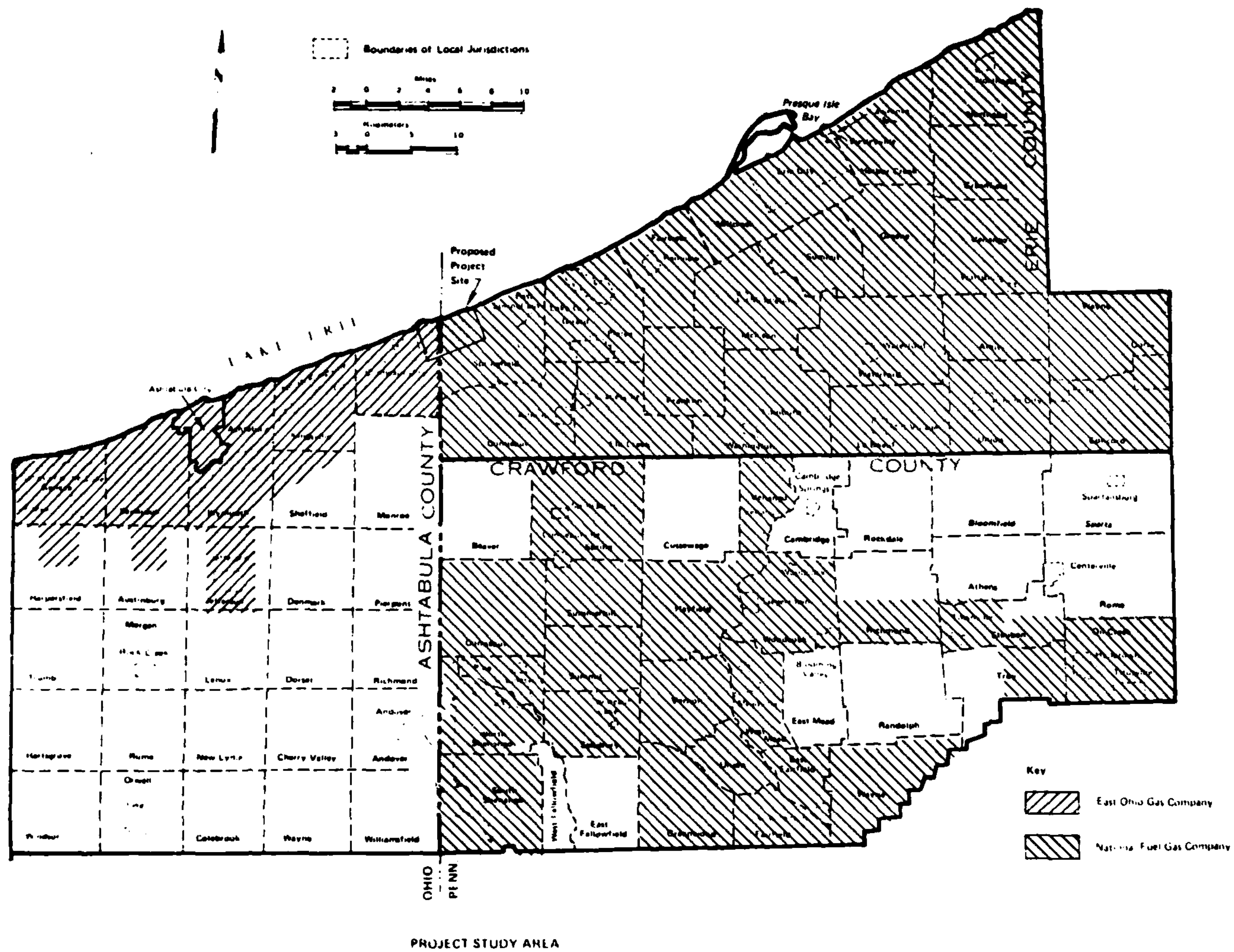

FIGURE 2–50 GAS UTILITY SERVICE AREAS IN THE REGIONAL STUDY AREA

gas purchased in the Southwest to meet its needs. Reliance on transmission company purchases rose to approximately 80 percent of supply in the late sixties. However, in 1971, gas curtailments were applied by pipeline suppliers amounting to 1.0 billion cubic feet (BCF) (0.1 percent of total pipeline supply). Gas curtailments are expected to be about 132 BCF (19.1 percent of total pipeline supply) in 1977. The inability of pipeline suppliers to meet contractual commitments led CNG to explore five major potential sources of additional supply: 1) gas produced or purchased locally in the Appalachian area, 2) gas produced or purchased in the Gulf of Mexico and adjoining areas, 3) imported liquefied natural gas, 4) imported Canadian gas, and 5) coal gasification. In 1976, total CNG supply was slightly over 800 BCF. Approximately 73 percent of the supply was provided by pipelines, 22 percent by local Appalachian-produced and purchased gas, and five percent by Gulf gas. In 1981, total CNG supply projected to be over 850 BCF with approximately 58 percent of the supply expected to be provided by pipelines, 18 percent by local Appalachian gas, 12 percent by Gulf gas, and 12 percent by liquefied natural gas (LNG). Liquefied Natural Gas deliveries from Algeria to Cove Point, Maryland, are scheduled to commence in 1978. By 1979, LNG deliveries (via Cove Point) to CNG are expected to reach a level of 131 BCF annually. Gulf area supplies are already at a level of about 50 BCF annually and are expected to more than double by 1981. Local Appalachian supplies are currently at a level of somewhat over 100 BCF, and are expected to remain at this level for the foreseeable future. CNG operates 27 storage fields with a reservoir capacity of approximately 800 BCF. It is the largest gas storage operation in the United States.

Pennsylvania Regional Study Area

2.448
The NFG system is an integrated gas system dependent primarily on southwest pipeline gas supply. The principal communities served by the system are Buffalo, Niagara Falls, Dunkirk, and Jamestown, New York, and Erie, Sharon and Oil City, Pennsylvania. In 1976, the system received approximately 83 percent of its gas supply through long-term contracts from suppliers which obtain all or a large portion of such gas from the Southwest. Approximately seven percent of the gas received was natural gas produced and purchased from the Appalachian area, about two percent was manufactured gas and about eight percent was synthetic gas (SNG). The historical supply pattern for the NFG system is presented in Table 2-263. Since the early seventies, gas curtailments were applied by pipeline suppliers to NFG. In 1976 deliveries from southwest suppliers were reduced nearly 21 BCF or 11 percent of contract volumes. Curtailments are expected to continue for at least one more year. For the near future, increased SNG receipts and increased supply from local producers are

Table 2-263

Supply Characteristics -- National Fuel Gas Company

Supply Type (Billion Cu Ft) (Percent of Total Supply)	1966	1970	1971	1972	1973	1974	1975	1976
Purchased	63	86	92	84	101	102	100	105
Percent	9	10	11	10	12	12	12	13
Purchased - Pipelines	553	671	659	660	646	633	599	581
Percent	75	75	76	75	74	74	74	72
Purchased - Local Producers	122	115	118	120	117	115	108	114
Percent	17	13	14	14	13	14	13	14
Purchased - Temp. Supplies	0	24	1	14	12	-	4.9	9.1
Percent	0	3	0	2	1	0	0	1
Total Gas Supply	738	896	870	878	876	850	812	809
Percent	100	100	100	100	100	100	100	100
Storage Change	17	(63)	(5)	27	(26)	17	(9)	49
Used and Unaccounted	(36)	(23)	(21)	(32)	(31)	(32)	(34)	(47)
Total Gas Delivered to Customers	719	810	844	873	819	835	769	811

Note: Data in parenthesis reflect negative values.

Source: Consolidated Natural Gas Company Annual Reports, 1970-1976.

Table 2-263 (Continued)

Supply Type (Billion Cu Ft) Percent of Total Supply	1966	1970	1971	1972	1973	1974	1975	1976
Purchased Pipelines	172	206	217	214	210	205	190	187
Percent	87	91	92	91	92	89	83	83
Purchased - Local Producers	6.0	4.5	4.1	4.4	4.4	4.5	7.5	9.5
Percent	3	2	2	2	2	2	3	4
Produced	9.4	9.0	6.8	8.8	8.5	8.8	6.9	5.7
Percent	5	4	3	4	4	4	3	3
Purchased SNG	0	0	0	0	0	6.2	18.0	18.6
Percent		0	0	0	0	3	8	8
Purchased Manufactured	10.7	7.6	6.3	6.2	6.2	5.8	5.1	5.1
Percent	5	3	3	3	3	3	2	2
Total Gas Supply	198	227	235	234	229	231	228	226
		100	100	100	100	100	100	100
Storage Change	(2.6)	(5.9)	(8.8)	5.8	(0.4)	0.6	(2.9)	1.0
Used and Unaccounted	(4.0)	(3.4)	(2.6)	(6.7)	(4.9)	(5.9)	(6.1)	(6.4)
Total Gas Delivered to Customers	191	218	223	233	223	225	219	220

Note: Data in parenthesis reflect negative values.

Source: National Fuel Gas Company Annual Report, 1976.

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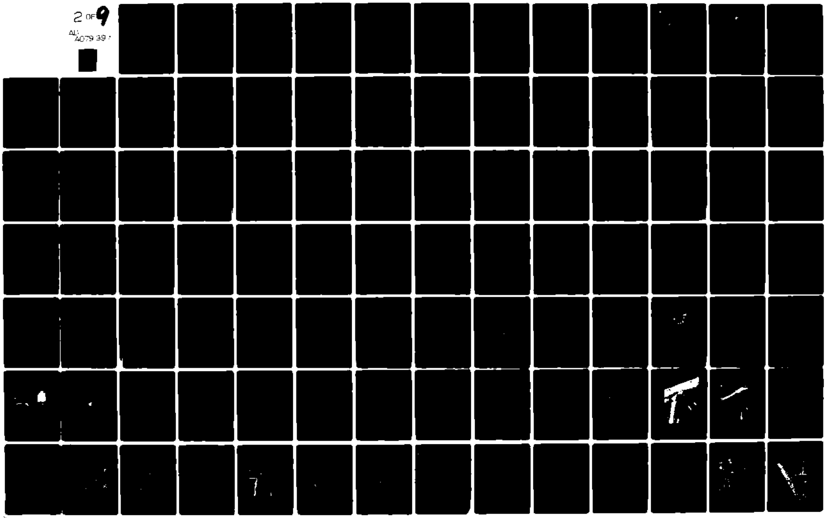


expected to offset possible reduction of pipeline supply. Beginning with 1977, local gas producers are expected to supply 15 BCF per year. Beginning in 1978, new LNG supply from Algeria is expected to be six BCF annually. NFG has 27 underground storage areas throughout its operating area, and operates four additional storage areas jointly with certain of its major pipeline suppliers.

Demand

Ohio Regional Study Area

2.449
Consolidated National Gas Company Demand. Approximately one-third of CNG's deliveries is to wholesale customers for resale. Of the gas distributed for end-use purposes, approximately 46 percent is consumed by residential customers, 19 percent by commercial customers, and about 33 percent by industrial customers. The demand characteristics for the CNG system are shown in Table 2-264. Since 1972-1973, total demand has remained roughly the same. Demand in the near future may be expected to increase in the two-four percent per year range. Average customer consumption in 1976 was about 18 thousand cubic feet (MCF) per residential customer, and 1,195 MCF per commercial customer. Average demand increased until 1972-73 and then declined to a level approximately the same as in 1970. The period 1972-1976 was a period of adjustment, reflecting increasing fuel costs, a weak economy, and implementation of conservation efforts. Average consumption in the near future is expected to remain constant or even decline. Average cost of natural gas increased at roughly seven percent per year between 1965 and 1976 for the residential and commercial classes and nearly 15 percent for the industrial class of customers. Most of these increases were actually encountered during the latter part of this period. In 1976, the average cost of natural gas was $1.76 per thousand cubic feet for residential customers, $1.66 for commercial customers, and $1.36 for industrial customers.

2.450
Customer Curtailments. Since 1970, EOG has not accepted new industrial customers and since the beginning of 1976, has not been accepting new residential and commercial customers in accordance with state regulatory rulings. Until 1977, EOG was able to minimize the impact of pipeline supply curtailments on its customers. However, in January 1977, EOG was forced to curtail its industrial customers sharply for a period of four weeks. Residential and commercial customers were not curtailed; however, they did practice serious conservation. Curtailments implemented by EOG are in accordance with the Public Utilities Commission of Ohio (PUCO) curtailment plan, which is based on the Federal Power Commission (FPC) end-use priority system. Curtailment of industry is expected to continue at varying

Table 2-264

Demand Characteristics -- Consolidated Natural Gas System

(Includes East Ohio Gas Company)

	1965	1970	1974	1975	1976	Annual Percent Change 1965/76
System Customer Demand (Billion Cu Ft)						
Residential	213.4	266.4	254.1	250.1	257.8	0.7%
Commercial	77.5	99.4	103.2	985	103.8	2.7
Industrial	N/A	207.7	N/A	183.8	198.3	0.8
Other	N/A	240.5	N/A	237.8	250.9	0.68(1)
Average Customer Demand (Thousand Cu Ft per Customer)						
Residential	192	202	187	183	189	0.1
Commercial	941	1211	1177	1128	1195	2.2
Industrial		125,000	N/A	123,000	137,000	1.5
Average Cost (Dollars per Thousand Cu Ft)						
Residential	0.86	0.84	1.27	1.50	1.76	6.7
Commercial	0.74	0.78	1.09	1.36	1.66	7.6
Industrial	N/A	0.59	N/A	1.09	1.36	14.9
Other	N/A	0.50	N/A	0.91	1.06	13.3

NA = Not Available.

(1) 1970-1976 period.

Source: Consolidated Natural Gas Company Annual Reports, 1970-1976.

levels through the 1977-1978 winter. After that, additional gas supplies are scheduled to be on stream-relieving supply contraints. It is anticipated that by 1979 new industrial customer restrictions will be lifted. Restrictions on new residential and commercial customers are expected to be lifted even earlier.

Pennsylvania Regional Study Area

2.451
National Fuel Gas Company Demand. Virtually all of NFG's deliveries are to end-use residential, commercial, and industrial customers. Approximately 50 percent is consumed by residential customers, 17 percent by commercial customers, and 33 percent by industrial customers. The demand characteristics for the NFG system are shown in Table 2-265. Demand increased at moderate rates until 1972-1973, then declined significantly. Demand in the near future may be expected to increase at a rate of two-four percent annually. Average demand in 1976 was about 171 MCF per residential customer, and 985 MCF per commercial customer. It increased at a rate of one percent and five percent between 1966 and 1972 for residential and commercial customers respectively; then decreased to three percent and 0.5 percent annually between 1972 and 1976, respectively. The period 1972-1976 was a period of adjustment reflecting increasing fuel costs, a weak economy and implementation of conservation efforts. Average cost of natural gas increased at an annual rate of 4-4.5 percent between 1966 and 1973 for each customer class. After 1973, average cost increased at a rate of over 20 percent annually. In 1976 the average cost of natural gas was $2.06 per MCF for residential customers, $1.76 for commercial customers, and $1.56 for industrial customers.

2.452
Customer Curtailments. NFG has not been accepting new industrial customers since 1972 and new residential and commercial attachments have been restricted in accordance with 1975 Pennsylvania regulatory rulings. NFG minimized the impact on its customers of pipeline supply curtailments. In August 1976, NFG requested permission from the PaPUC to add new customers. No decision has been made on this request. If the surplus supply projections prove accurate, removal of the restriction appears probable. In filings to PaPUC, NFG forecasts a supply surplus for the Pennsylvania part of its system. A 1.3 percent surplus is anticipated for 1977, 1.9 percent for 1978, and three percent for 1979. The Pennsylvania supply/demand balance for NFG is shown in Table 2-266.

Table 2-265

Demand Characteristics -- National Fuel Gas Company

	1966	1970	1971	1972	1973	1974	1975	1976	Annual Percent Change 1966/72	1972/76	1966/76
System Customer Demand (Billion Cu Ft)											
Residential	107.9	116.3	117.8	121.1	113.4	110.9	112.0	107.3	1.9%	-3.0%	0.0%
Commercial	25.1	32.1	33.7	37.9	37.6	37.1	38.3	36.3	7.1	-1.1	3.8
Industrial	55.1	66.8	68.7	70.1	69.1	74.3	65.4	66.4	4.1	-1.1	1.9
Other	2.9	2.8	3.1	3.5	3.1	3.1	3.3	3.0	3.2	-3.8	0.3
Average Customer Demand (Thousand Cu Ft per Customer)											
Residential	185	192	192	196	184	178	178	171	1.0	-3.4	-0.8
Commercial	764	945	978	1012	1026	1003	1037	995	4.8	-0.4	2.7
Industrial	37,000	42,000	43,000	44,000	44,000	47,000	23,000	44,000	2.9	0.0	1.7
Average Cost (Dollars per Thousand Cu Ft)											
Residential	0.86	0.95	1.08	1.17	1.19	1.35	1.76	2.06	4.7(1)	20.1(2)	9.1
Commercial	0.73	0.78	0.90	0.98	0.99	1.14	1.54	1.76	4.4(1)	21.1(2)	9.2
Industrial	0.59	0.61	0.72	0.77	0.78	0.96	1.35	1.56	4.1(1)	26.0(2)	10.2
Other	0.54	0.55	0.62	0.66	0.66	0.70	0.86	1.05	2.9(1)	16.7(2)	6.9

(1) 1966-73 period
(2) 1973-76 period

Source: National Fuel Gas Company Annual Report, 1976.

Table 2-266

Projected Pennsylvania Supply Demand Balance -- National Fuel Gas Company

Requirements	1976 BCF	1976 Percent	1977 BCF	1977 Percent	1978 BCF	1978 Percent	1979 BCF	1979 Percent
Residential	34.1	29.0%	33.1	42.3%	32.7	42.5%	32.2	42.6%
Commercial	12.7	15.3	12.7	16.2	12.6	16.4	12.6	16.7
Industrial	32.8	39.4	31.8	40.6	31.0	40.3	30.2	39.9
Other	3.7	4.4	0.7	0.1	0.7	0.1	0.7	0.1
Total Requirements	83.2	100.0%	78.3	100.0%	77.0	-	75.6	100.0%
Total Supply	83.2	-	79.3	-	78.6	-	78.0	-
Pipeline	73.7	88.5	69.1	87.2	66.7	84.9	65.9	84.5
Local Producers	2.8	3.4	3.5	4.4	5.2	6.6	5.4	6.9
SNG	6.7	8.1	6.6	8.4	6.6	8.5	6.7	8.6
Surplus	0.0	-	1.0	-	1.5	-	2.4	-

Source: Pennsylvania Public Utilities Commission, General-Supply Demand Form I. February 28, 1977, Natural Gas Curtailment in Pennsylvania--II; Center for Energy and Natural Resources Management, February, 1976.

c) Petroleum Products

2.453
Local wholesale and retail fuel supply dealers deliver petroleum products to individual customers. Each dealer has separate supply arrangements with major and independent oil companies. Petroleum products are supplied to the Regional Study Area from refineries in northern Ohio, western Pennsylvania, eastern Michigan, and terminals in the Cleveland area. The local petroleum supply system is supported by the national marketing systems of major and independent oil companies and generally the local suppliers consider the availability of petroleum products in the Regional Study Area to be ample. Based on discussions with local wholesalers, demand has been growing at about three percent per year and is expected to continue to grow at this rate. Petroleum supply patterns for the Regional Study Area are summarized in Table 2-267.

Land Use and Zoning

Land Use Patterns of the Regional Study Area

2.454
In the early 1970's, about 90 percent of the Regional Study Area was classified as rural/agricultural, as shown in Table 2-268 and Figures 2-51 and 2-52. This classification includes low-density rural residential uses as well as active and inactive farmland. While the distribution of land use has shifted towards more urban development in recent years, the change has been minor. In 1977, 89.4 percent of the unincorporated areas of Ashtabula County were still classified as agriculture/rural. (2-56) Slow growth in higher-density residential areas consumed less than five percent of remaining rural land, while the distribution of other uses remained relatively constant. Recent growth in the area has followed two patterns: the first extends radially from the principal urban centers on the lakefront (Erie, Ashtabula City and Conneaut), while the other has followed new infrastructure in more isolated areas. The latter category includes residential development around the Pymatuning Reservoir and the commercial strip development which occurred in the lake plain along Route 20 and access areas to I-90.

Land Use Characteristics in the Principal Study Area

a) Physical Characteristics

Ohio

2.455
Ashtabula County is divided into three cities, six villages, and 27 townships and encompasses approximately 420,000 acres of land (most

Table 2-267

Petroleum Supply System in the Regional Study Area

Refineries

Location	Company	Capacity (MB/D)
Ohio		
Lima	Standard Oil	168
Toledo	Standard Oil	120
Toledo	Gulf Oil	125
Toledo	Sun Oil	125
Cleveland (Cincinnatti)	Gulf Oil	42
Pennsylvania		
Warren	United Refining	52
Michigan		
Detroit	Marathon Oil	48
Dearborn	Mobil Oil	45

Product Pipelines

Company	Pipeline Size (Inches)	Cleveland Area Terminals	Access to Refinery Centers
Buckeye	12	Cleveland Bradley Rd. Aurora	Warren, Pa. and Toledo, Ohio
Sun	8	Bradley Rd. Aurora	Newark, N. J. and Toledo, Ohio
Inland	6	Cleveland Akron Mogadore Randolph	Lima, Toledo, Ohio
Arc	6	Cleveland Mogadore Randolph	Toledo, Ohio (Connected to Texas Eastern and Allegheny pipelines in Steubenville.)

Table 2-267 (Continued)

Company	Pipeline Size (Inches)	Cleveland Area Terminals	Access to Refinery Centers
Sohio	6	Cleveland Akron Randolph	Warren, Pennsylvania
Laurel	14	Cleveland Bradley Rd. Randolph	Marens Hook, Pa.

Source: Arthur D. Little, Inc. compilation.

Table 2-268

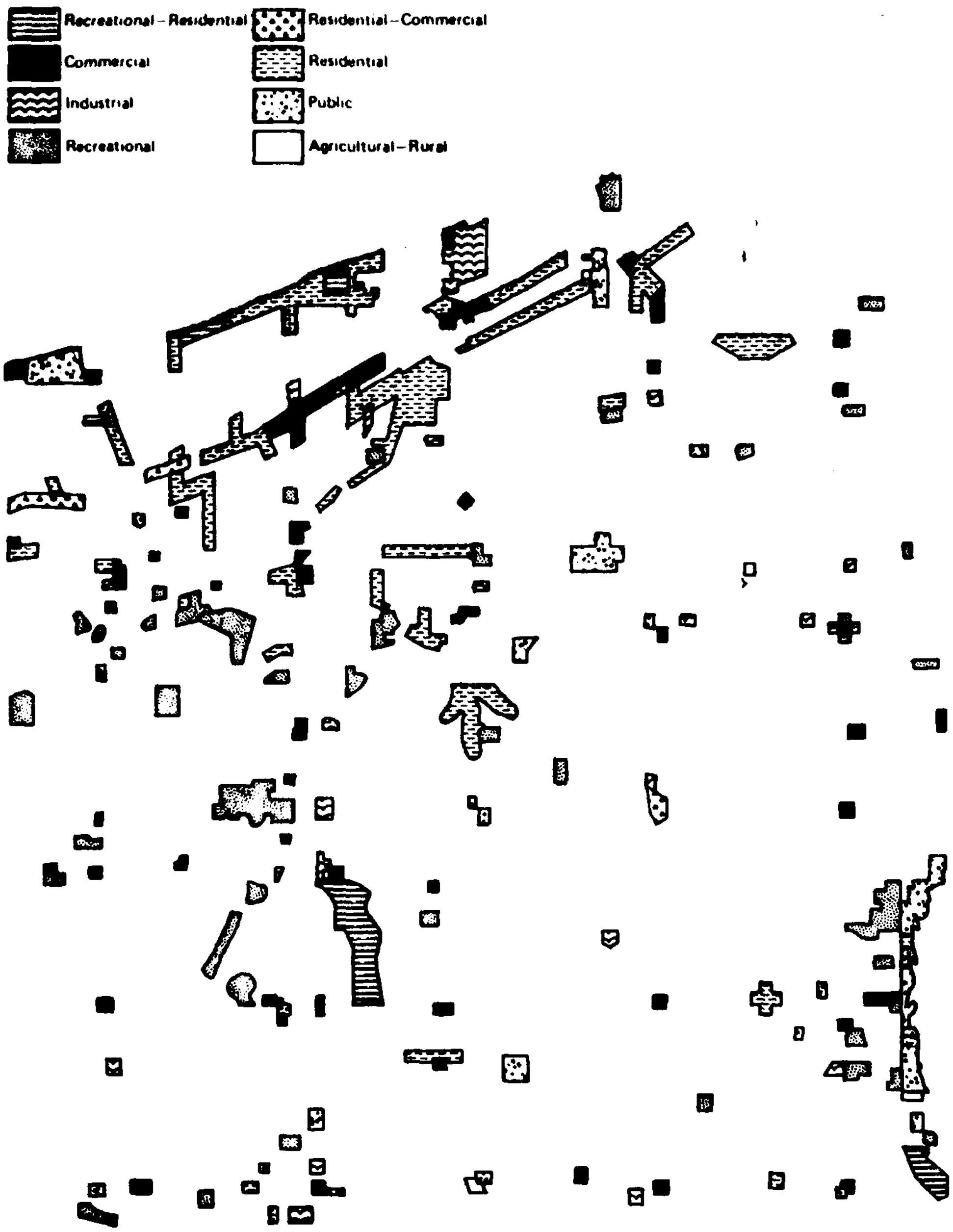
Existing Land Use in the Regional Study Area

Land Use Category	Ashtabula County (1971)[1]		Crawford County (1970)		Erie County (1971)	
	Acres	%	Acres	%	Acres	%
Residential	11,586	2.7%	21,445	3.2%	28,417	5.6%
Commercial	1,608	0.4	1,615	0.2	3,086	0.6
Industrial	1,588	0.4	1,610	0.2	1,645	0.3
Institutional	8.165	1.9	5,322	0.8	4,933	1.0
Recreation	9,093	2.2	56,800	8.4	14,322	2.8
Agricultural and Open	389,422	92.4	593,150	87.2	437,180	85.5
Transportation	N/A	N/A	N/A	N/A	31,715	4.2
Total	421,462	100.0%	679,942	100.0%	511,298	100.0%

N/A = Not Available.

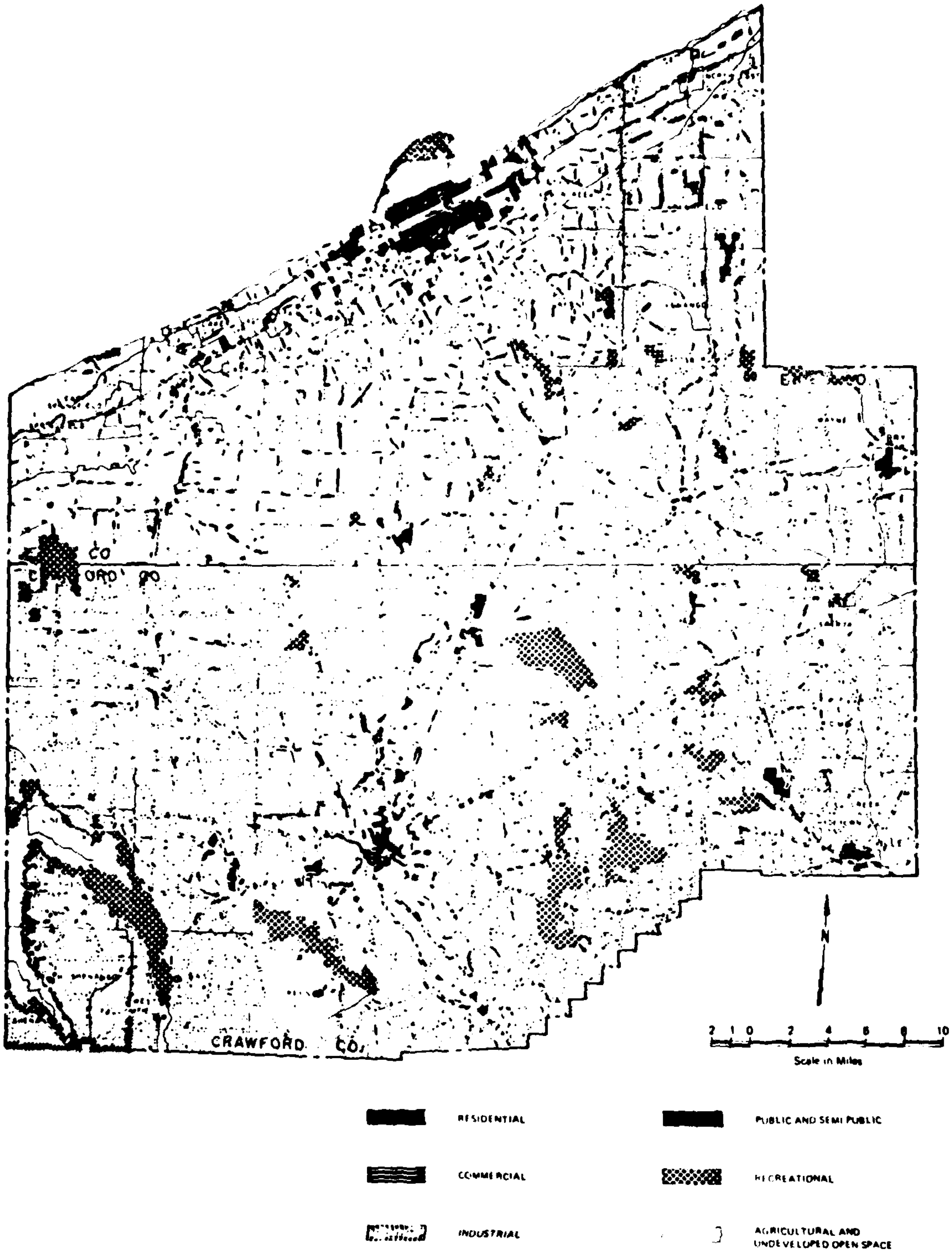
(1) Includes only unincorporated areas, which account for over 90% of the acreage in the County, but do not include the principal urban areas - Ashtabula City and Conneaut.

Source: Baseline reports prepared by the States of Ohio and Pennsylvania, 1977.



Original Source: Ashtabula County Planning Commission.
As Located In: Baseline Study of Ashtabula County, Ohio.
A Basic Planning Document of Socio-Economic Characteristics, Volume 2.
The Regional Development Office of Ashtabula County at Conneaut, Ohio. The State of Ohio Department of Economic and Community Development, August, 1977.

FIGURE 2–61 EXISTING LAND USE IN ASHTABULA COUNTY



Original Source: Erie County Land Use Plan, Erie County Metropolitan Planning Commission, 1971.
The Comprehensive Plan for Crawford County, Crawford County Planning Commission, September, 1973.
As Located In: Northwest Area Profile, A Baseline for the Future, Commonwealth of Pennsylvania, 1977.

FIGURE 2-52 EXISTING LAND USE IN ERIE AND CRAWFORD COUNTIES

of which is unincorporated). Land use in Ashtabula County in 1977 was 89.3 percent agricultural/rural and 3.1 percent residential as compared to 94.9 percent and 2.5 percent, respectively, in 1960. The trend in the past few years, as illustrated in Table 2-269 has been a gradual decline in the use of land for agricultural/rural purposes and an increase in the use of land for residential purposes. The most recent available data on the distribution of land use in the six Coastal Communities of Ohio is presented in Table 2-270.

Pennslyvania

2.456
Changes in land use classifications and the accounting methodology employment tend to distort comparisons made between use distributions in different areas and years, but not to the degree that trends between years and between counties are useless. In some instances transportation does not represent a discrete category but is included in all the other categories. This is the situation with Crawford County statistics. Also, in Crawford County, playgrounds and local parks are included under "institutional" (public and semi-public) whereas in Erie County, playgrounds and local parks are included under "recreation." In all probability, in the early years, land owned by industry but remaining undeveloped was classified as industrial, when it could have more appropriately been classified otherwise. Despite these caveats, the data presented below are believed representative of the degree and nature of changes in the area.

Erie County

2.457

The information contained in Table 2-27 indicates a gradual trend toward urban uses within Erie County. In 1959 approximately 3.4 percent of the county was utilized for developed uses (residential, commercial industrial, recreation -- excluding State game lands -- institutional and transportation). By 1971, this percentage had risen to 14.5 and by 1975 to 14.9. However, these percentages were derived from a declining base of reported total acreage. Most of the growth in residential acreage occurred between 1959 and 1963 increasing by 92.7 percent (refer to Table 2-271). The growth rate slowed to 43.2 percent between 1963 and 1971 and 5.6 percent between 1971 and 1975. The growth rate in acreage devoted to commercial activity was 3.3 percent, 62.4 percent, and 28.3 percent, respectively. In previous years, industrial land use in Erie County included all industrial owned property, developed or otherwise, and in all probability railroads, since they were not classified elsewhere. Therefore, the acreage recorded in 1959 was gross acreage and

Table 2-269

Distribution of Land Use Types in Ashtabula County Unincorporated Areas -- 1960 and 1971

Land Use Category	1960 Acres	1960 Percent	1971 Acres	1971 Percent
Residential	10,334	2.5%	11,585.93	2.7%
Commercial	974.75	0.2	1,608.45	0.4
Industrial	1,909.27	0.5	1,588.41	0.4
Institutional	5,804.9	1.4	8,164.67	1.9
Recreation	2,631.61	0.6	9,092.71	2.2
Agricultural and Undeveloped Open Space	399,807.49	94.9	389,421.65	92.4
Transportation				
Total	421,461.82		421,461.82	

Source: "Land Use 1977 Ashtabula County" (Preliminary Draft), Ashtabula County Planning Commission, Jefferson, Ohio, 1977.

Table 2-270

Existing Land Use in the Ohio Coastal Communities

	Agri.-Rural		Residential		Recreational		Commercial		Institutional		Industrial		Transportation	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Conneaut City 1977 Total - 16,330	12,239	75.0%	1,680	10.3%	74	0.5%	86	0.5%	1,533	9.4%	791	5.0%	(4,091)	(25.0%)
Kingsville Township 1977 Total - 8,520	7,015	82.3	481	5.6	80	0.9	81	1.0	380	4.5	0	0	483	5.7
North Kingsville Village 1972 Total - 5,358	3,782	70.6	378	7.1	72	1.3	123	2.3	617	11.5	61	1.1	325	6.1
Ashtabula Township 1977 Total - 8,485	5,347	63.0%	1,231	14.5%	N/A	-	105	1.2%	553	6.5%	1,028	12.1%	221	2.6%
Ashtabula City 1969 Total - 4,741	1,390	29.3	1,282	27.0	157	3.3	177	3.7	325	6.9	575	12.1	835	17.6
Saybrook Township 1977 Total - 20,080	16,386	81.6	1,467	7.3	877	4.4	365	1.8	144	0.7	313	1.6	528	2.6
Ashtabula County 1977 Total - 421,208	376,277	89.3	13,141	3.1	9,316	2.2	1,456	0.3	8,873	2.1	1,785	0.4	10,360	2.5

N/A = Not Available.

( ) - denotes questionable data point.

Source: "Land Use 1977 Ashtabula County" (Preliminary Draft), Ashtabula County Planning Commission, Jefferson, Ohio, 1977.
"Local Government Land Use Responsibilities and Opportunities," Commonwealth of Pennsylvania, Bureau of Planning, Department of Community Affairs, Northwest Pennsylvania Futures Committee Report, April, 1977.
Telephone Communication, Walter Krothe, Buildings Department, Ashtabula County.

Table 2-271

Trends in Erie County Land Use

Land Use Category	1959 Acres	1959 %	1963 Acres	1963 %	1971 Acres	1971 %	1975 Acres	1975 %
Residential	10,299	2.0%	19,850	3.8%	28,417	5.6%	30,015	6.0%
Commercial	1,839	0.4	1,900	0.4	3,086	0.6	3,960	0.8
Industrial	2,283	0.4	2,250	0.4	1,645	0.3	2,520	0.5
Institutional	N/A	-	3,800	0.7	4,933	1.0	5,761	1.2
Recreation	3,247	0.6	9,000	1.7	14,322	2.8	11,070	2.1
Agricultural & Undeveloped Open Space	505,005	96.6	462,400	89.0	437,180	85.5	426,030	85.1
Transportation	N/A	-	20,800	4.0	21,715	4.2	21,151	4.2
Totals	522,673	100.0%	520,000	100.0%	511,298	100.0%	500,507	100.0%

N/A = Not available by land use comparison.

Source: "A Summary Guide to Action," Erie Metropolitan Planning Department, 1970.
"Land Use Update 1975," Erie Metropolitan Planning Department, 1975.

somewhat inflated. From field surveys, employment and production level statistics, it appears that industrial land acreage has increased in direct proportion to urban-related uses. Interpretation is difficult for institutional and recreational land uses because of the nondiscrete nature of the categories. If these categories are taken as a whole and viewed over the 12-year period (1965-1975), a 31 percent increase has occurred. Between 1959 and 1963, 1963 and 1971, and 1971 and 1975, agricultural land use declined 8.4 percent, 5.5 percent and 2.6 percent, respectively. This declining trend is probably due to the conversion, consolidation, and abandonment of farms. The increase in urban uses mentioned earlier was at the expense of agricultural land in particular and, to a lesser degree, undeveloped open space. The second highest urban-related land use is transportation (i.e., railroads, airports, and roads). Erie County is located at the hub of a network of highways, and recent construction of I-90 and I-79 has produced an increase in the acreage devoted to transportation uses. The apparent decline in railroads and airports is again a result of land use reclassification.

Crawford County

2.458
Land use distribution in Crawford County is shown in Table 2-272. There is some inconsistency of data in that transportation is included with the gross acreage of the various use categories. The distortion is incidental because of the very rural nature of the county, with relatively little transportation development. Urban-related uses comprised 4.4 percent of total land use within Crawford County in 1970. Of this amount, 71.5 percent was residential, 5.4 percent commercial, 5.4 percent industrial, and 17.7 percent institutional. Of the 71.5 percent residential, 9.6 percent was seasonal residential located near the county's major water resorts including Conneaut Lake, Pymatuning Reservoir, and the Spartansburg area. Commercial development is concentrated in Meadville and around Conneaut Lake, and to a lesser degree in Titusville and Cochranton. Industrial development is concentrated in Meadville, the Geneva and Saegertown areas, and in Titusville. Together both commercial and industrial development is less than 0.5 percent of Crawford County land use. Recreational land use accounted for more than eight percent of the county area. Pymatuning State Park and State game lands each accounted for approximately 21,000 acres. The remaining 25 percent, or 13,960 acres of recreational land use was taken up in the Erie National Wildlife Refuge and around Woodcock Lake. Eighty-seven percent of the county was designated as agricultural and undeveloped open space with approximately 51 percent (267,000 acres) of this land classified as forested. Land use increases within the county were greatest in the forested land category in 1970. (2-57). This increase was at least partially due to the decline in farming, which

Table 2-272

Crawford County Land Use Distribution -- 1970

Land Use Category	Acres	%
Residential	21,445	3.2%
Commercial	1,615	0.2
Industrial	1,610	0.2
Public and Semi-Public	5,322	0.8
Recreation	56,800	8.4
Agricultural and Open (Including Forestland)	593,150 (267,000)	87.2 (45.0)
Transportation	N/A	-
Total	679,942	100.0%

N/A = Not Available

Source: "Comprehensive Plan, Crawford County, Pennsylvania," 1970, Beckman, Yoder & Seay, Inc.

resulted in an increase in the number of acres reverting to woodland. Woodlands prevail throughout the county but particularly in the eastern half. Of the reported agricultural and open space, 37 percent was in crops, 10 percent in pasture land, two percent in other non-agricultural uses and the remaining area forest.

The Pennsylvania Coastal Communities

2.459
The gradual urbanizing trend described for Erie County has been experienced to some degree in all parts of the Regional Study Area, including the Coastal Communities. Between the years 1971 and 1975, Erie County developed uses rose 11.7 percent to 12.7 percent. During this same period, growth in developed uses was 20.6 percent to 25.9 percent in the four Pennsylvania Coastal Communities. The developed area follows the level terrain of the lake plain in an east-west direction, forming a crescent shape around Erie City. Land use distribution by individual community is shown in Tables 2-273 through 2-279. Of the Coastal communities in Pennsylvania, Millcreek Township, and Lake City Borough are the most urban areas and the most densely populated with a population density of both 8.5 persons per acre. The other areas are less densely populated, on the order of three to five persons per acre. Given the predominantly rural and agricultural nature of the Coastal communities, commercial, industrial, and recreational land use combined represents about five percent of total land use. For example, Platea Borough has no land designated as industrial or recreational. Commercial activity in the region varies in accordance with the level of residential land use which in turn depends on population levels. The greatest concentration of commercial activity occurs in Millcreek Township with 39,000 residents. Institutional land distribution has a direct correlation with population levels, again the greatest allocation of land to these uses occurring in Millcreek Township.

Institutional Characteristics

Federal Government

2.460
Federal legislation affecting land use has taken several forms. A number of these are applicable to land use in the Principal Study Area. The Coastal Zone Management Act. The Coastal Zone Management Act of 1972 (P.L. 92-583) authorized "management program development grants" to any coastal state, aimed at the development of a program for managing land and water resources in the coastal zone. In addition to an identification of the boundaries of the coastal zone and designation of areas of particular concern, a State, to be eligible for funding, must define permissible land and water uses. The States

Table 2-273

Land Use in Girard Township

Land Use Category	1971[1] Acres	1971[1] %	1975[2] Acres	1975[2] %
Residential	846	4.2%	909	4.6%
Commercial	236	1.2	106	0.5
Industrial	10	*	246	1.3
Public and Semi-Public	187	0.9	17	0.1
Recreation	454	2.2	248	1.3
Agricultural and Undeveloped	17,623	86.7	17,153	87.5
Transportation	969	4.8	916	4.7
Total	20,325	100%	19,595	100%

* Less than 0.1%.

Source: [1] "Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

[2] "Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department, p. 58.

Table 2-274

Land Use in Girard Borough

Land Use Category	1971[1] Acres	1971[1] %	1975[2] Acres	1975[2] %
Residential	272	19.2%	296	19.6%
Commercial	44	3.1	43	2.8
Industrial	23	1.6	29	1.9
Public & Semi-Public	138	9.7	273	18.1
Recreation	0	0	57	3.8
Agricultural and Undeveloped	773	54.5	628	41.6
Transportation	169	11.9	184	12.2
Total	1419	100%	1510	100%

Source: (1)"Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

(2)"Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department, p. 58.

Table 2-275

Land Use in Platea Borough

Land Use Category	1971[1] Acres	1971[1] %	1975[2] Acres	1975[2] %
Residential	96	4.6%	114	6.3%
Commercial	9	0.4	8	0.4
Industrial	0	-	0	0
Public & Semi Public	6	0.3	20	1.1
Recreation	0	-	0	0
Agricultural and Undeveloped	1881	90.7	1591	87.6
Transportation	83	4.0	83	4.6
Total	2075	100%	1816	100%

Source: (1) "Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

(2) "Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department, p. 58.

Table 2-276

Land Use in Lake City Borough

Land Use Category	1971[1] Acres	1971[1] %	1975[2] Acres	1975[2] %
Residential	236	20.9%	270	24.3%
Commercial	41	3.6	24	2.2
Industrial	93	8.2	115	10.4
Public & Semi-Public	41	3.6	48	4.3
Recreation	8	0.7	3	0.3
Agricultural and Undeveloped	596	52.8	528	47.6
Transportation	115	10.2	121	10.9
Total	1130	100%	1109	100%

Source: (1)"Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

(2)"Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department, p. 58.

Table 2-277

Land Use in Fairview Township

Land Use Category	1971[1] Acres	1971[1] %	1975[2] Acres	1975[2] %
Residential	1,673	9.6%	1,453	8.3%
Commercial	116	0.7	338	1.9
Industrial	52	0.3	138	0.8
Public & Semi-Public	299	1.7	753	4.3
Recreation	106	0.6	721	4.1
Agricultural and Undeveloped	14,280	81.5	13,039	74.6
Transportation	989	5.6	1,029	5.9
Total	17,515	100%	17,471	100%

Source: [1]"Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

[2]"Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department, p. 58.

Table 2-278

Land Use in Fairview Borough

Land Use Category	1971[1] Acres	1971[1] %	1975[2] Acres	1975[2] %
Residential	204	24.1%	227	27.1%
Commercial	22	2.6	22	2.6
Industrial	0	-	1	0.1
Public & Semi Public	60	7.1	64	7.7
Recreation	0	-	0	
Agricultural and Undeveloped	496	58.6	422	50.4
Transportation	64	7.6	101	12.1
Total	846	100%	837	100%

Source: [1] "Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

[2] "Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department, p. 58.

Table 2-279

Land Use in Millcreek Township

Land Use Category	1971[1] Acres	1971[1] %	1975[2] Acres	1975[2] %
Residential	4,233	22.7%	4,605	21.3%
Commercial	661	3.5	813	3.8
Industrial	185	1.0	248	1.1
Public & Semi Public	701	3.8	4,187	19.4
Recreation	107	0.6	194	0.9
Agricultural and Undeveloped	10,743	57.5	9,405	43.5
Transportation	2,049	10.9	2,162	10.0
Total	18,679	100%	21,614	100%

Source: [1] "Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

[2] "Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department, p. 58.

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Land Use in Fairview Borough

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Commercial	22	2.6	22	2.6
Industrial	0	-	1	0.1
Public & Semi Public	60	7.1	64	7.7
Recreation	0	-	0	
Agricultural and Undeveloped	496	58.6	422	50.4
Transportation	64	7.6	101	12.1
Total	846	100%	837	100%

Source: [1]"Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

[2]"Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department, p. 58.

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Source: [1]"Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

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Land Use in Fairview Borough

Land Use Category	1971 (1) Acres	1971 (1) %	1975 (2) Acres	1975 (2) %
Residential	204	24.1%	227	27.1%
Commercial	22	2.6	22	2.6
Industrial	0	-	1	0.1
Public & Semi Public	60	7.1	64	7.7
Recreation	0	-	0	
Agricultural and Undeveloped	496	58.6	422	50.4
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Source: [1]"Summary & A Guide to Action," Erie Metropolitan Planning Department, p. 58.

[2]"Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department, p. 58.

also must identify the means by which they will control land and water uses, including the local, areawide, State, regional, and interstate agency responsibilities for the implementation of the program. Administrative grants may be awarded for the implementation of this program, if the Secretary of Commerce ascertains that, along with meeting the other requirements, the State has the authority to administer land and water use regulations, control development and when necessary, acquire property to achieve conformance with the management program.

2.461
The National Flood Insurance Act. The National Flood Insurance Program is administered by the Department of Housing and Urban Development. To meet the eligibility requirements for such insurance, communities must develop land use provisions regulating development in land exposed to flood damages guiding development away from flood zone areas, and improving long range management of flood zone areas. (2-58) These requirements direct communities to delineate flood plain areas. Once a locality has identified flood plain areas with special flood hazards, any new structures in these areas are insurable at the full risk rate.

2.462
The Clean Air Act. Under the amended Clean Air Act, the location of major proposed new direct sources of air pollution is subject to a preconstruction review by the EPA and/or the State. In order to perform such reviews, the State must develop adequate, EPA-approved procedures to prevent the continued violation of any primary national ambient air quality standard and to prevent significant deterioration of air quality. (2-59) While the amended Act no longer refers to this type of review as a "land use" control, the EPA and the State agencies exercising this authority can affect land use patterns by restricting the location options of major industrial facilities. These restrictions are new and have not limited development in the Principal Study Areas to date.

2.463
The Clean Water Act. The Clean Water Act is administered by the USEPA with the exception of Section 404 which is the responsibility of the Corps of Engineers. Under this legislation, all major proposed new source discharges must meet National Standards of Performance for effluent reduction (i.e., effluent guidelines) reflecting best available control technology. In addition, effluent guidelines are being developed for "priority pollutants," pretreatment effluents, and thermal discharges. In Pennsylvania, permitting authority for new sources still rests with the EPA through the National Pollutant Discharge Elimination System (NPDES) although the responsibility for permit issuance is expected to be delegated to the

Commonwealth in the near future. Ohio has developed NPDES regulations approved by the EPA, and administers the system. In the NPDES process, State water quality standards are combined with the EPA's effluent limitations to decide the acceptability of a proposed new source discharge. The EPA retains the authority to review and enforce, in the absence of proper state enforcement, all NPDES permits issued. The Secretary of the Army acting through the Corps of Engineers retains the authority for regulation of discharges of dredged or fill material into waters of the United States or their adjacent wetlands pursuant to Section 404 of the Act. As with the new source reviews pursuant to the Clean Air Act, land use in the Principal Study Area has been minimally affected by new source reviews under the Water Law. However, the same potential for influencing major discharge locations exists under both laws. Sections 201 and 208 of the Clean Water Act authorize funding for interceptor sewers, sewage treatment plants, and areawide waste treatment planning. These funds are administered through the States and require comprehensive plans and prioritization of areas in need of funding for sewer systems. The availability of such funding has recently become a defacto influence on land use (i.e., growth constraint or stimulus) in the Principal Study Area.

State Government

2.464
The State of Ohio and the Commonwealth of Pennsylvania have regulations that directly affect some land use practices, but in most cases they have delegated the authority to regulate land use to the county and local governments.

Ohio

2.465
Ohio, through the Department of Natural Resources, is completing the second year of its Coastal Zone Management Program. The State is presently taking inventory of its needs, uses, and areas of particular concern and is in the initial stages of identifying and coordinating existing regulations and agencies with the regulatory power to conform with the requirements of the Federal Coastal Zone Management Act. (2-60) A coordinated implementation program for coastal zone land use planning and management in the Principal Study Area has not been developed. Ohio also conducts a Scenic Rivers Program through its Department of Natural Resources. Once a river has been designated "wild," "scenic" or "recreational," a local citizens' advisory counsel is appointed to help develop land use planning and programs for zoning, easements, and land acquisitions to protect the designated stream. (2-61) The enabling legislation for the Ohio Scenic Rivers Program has reportedly undergone serious court

challenge in the recent past, and its future is uncertain. (2-62) There is no State level flood plain legislation in Ohio. Existing legislation permits the chief of the Division of Water, subject to approval of the Director of Natural Resources and the Governor, to direct the impoundment water for flood purposes. The task of formulating and coordinating a system of water conservation and flood control is delegated to the Boards of County Commissioners. (2-63) Ohio created an Environmental Protection Agency to administer laws and regulations and take actions necessary to comply with Federal laws and regulations. Under this enabling legislation, the Director of the Ohio EPA can adopt, modify or repeal regulations relevant to maintaining air and water quality. The Ohio EPA issues permits for all new sources of air and water pollution. (2-63) Ohio has been delegated NPDES permitting authority by the EPA. Thus, permits required by the State for new sources of air pollution and/or water effluent would cover both State and Federal requirements in most instances. The USEPA retains the right to review these permit actions. Such permit actions can be a major influence on land use, but, with the exception of uses requiring permits for on-lot sewage disposal, they have had minimal effect on the Principal Study Area. The Revised Code enables the Public Health Council to make regulations throughout the State governing the locations, drainage, and sanitation facilities of mobile home parks and trailer parks. However, ultimate control over these facilities, including the right to exclude them from a community, rests with those local governments having their own zoning ordinances. (2-63)

2.466
Model Zoning Regulations provided by the State of Ohio for use by county/local planners encourage a flexible approach to zoning, emphasizing creative planning versus zoning changes. Recommended approaches are as follows: (1) General zoning categories should be established rather than lists of specific permitted uses; (2) Local regulations should indicate whether or not planned unit developments will be allowed; (3) Business districts should be zoned by the type of use (local, central, or general), considering such things as traffic volume that such an area will generate; and (4) Industry should be zoned by characteristics such as the level of associated noise and smoke. The model ordinance encourages planned and regulated mobile home parks and single-unit mobile home dwellings as alternative types of housing rather than candidates for exclusion. (2-64) The "Model Subdivision Regulations," provided by the State of Ohio also suggest guidelines for subdivision approval and design requirements. Principal suggestions are as follows: (1) Review of plans by the County Engineer and County Health Department, with the Health Department having the authority to require that central water and/or sewage treatment systems be constructed by the subdividers. (2) The county should adopt design and improvement criteria for treatment

plants based on Ohio Department of Health minimum requirements. (3) Subdivisions located on areas subject to "periodic flooding" should be rejected. (4) Improvements should be required for developments located in areas of poor drainage or adverse soil characteristics. (5) Minimum lot sizes of one acre are suggested for areas without central sewage treatment with multi-family, commercial and industrial developments prohibited. (6) Design standards for streets for all types of developments. These would prohibit the directing of industrial traffic into residential areas and limit commercial traffic on local streets as well as establishing minimum widths and construction standards. (7) The preservation of natural features should, where possible, be accomplished; and public sites or open space should be provided. (2-65)

Pennsylvania

2.467
Pennsylvania, through the Erie Metropolitan Planning Department, has completed a preliminary coastal zone resource analysis, (2-66) and has started to review the adequacy of existing legal authorities for implementation of a management program as required by the Federal legislation. Categories where management authority does not exist in Pennsylvania include comprehensive coastal zone management, State-wide land use controls, and wetlands protection. Modification of existing authority is needed to implement the program in other areas, such as a State flood protection plan (at present authorized at the local level), land acquisition, and public beach access. The implementation of a comprehensive coastal zone management program that would affect land use in the Pennsylvania Principal Study Area appears to be too far in the future to affect the proposed project. However, State authority exists for implementation of selected land use management techniques, erosion control, air and water pollution control, and solid waste disposal. As part of the Pennsylvania Scenic Rivers Act, an inventory and prioritization of eligible streams have been completed. Planning and implementation options have not been fully developed by the Pennsylvania Department of Environmental Resources (DER) and local governments. (2-67) However, the DER is authorized by the Act to require scenic easements, using the power of condemnation where necessary. (2-67) As in Ohio, the Commonwealth of Pennsylvania requires permits that fulfill EPA requirements for new sources of air emission. However, Pennsylvania does not yet have NPDES permitting authority. Thus, all new community and individual sewage systems and industrial sources require permits from the Pennsylvania DER (or designated local agency), as well as the EPA. (2-68) A DER permit is also required for erosion control plans associated with construction activities. The Pennsylvania Sewage Facilities Act requires counties to adopt water and sewer plans monitored by the DER and in Crawford and Erie Counties such plans have

already been formulated. Regulations prohibit on-lot sewage disposal systems in flood plain soils or in areas where the slopes greater than 25 percent. The Pennsylvania Water Quality Planning and Monitoring Program established conservation streams subject to more stringent water quality standards. If enforced, these could tend to restrict certain development activities in designated watersheds. Both Crooked Creek and Godfrey Run are designated conservation streams in the Coastal Communities of the Pennsylvania Principal Study Area. (2-69) The Commonwealth, or its counties, may preserve, acquire or hold land for open-space use. This may be done through purchase, contract, or acquisition through condemnation. Property held in fee simply is offered for sale for two years. No funds have been made available for this program as of 1976. (2-70) The Commonwealth also requires permits for the establishment of disposal facilities for sanitary waste and solid waste.

County Government

Ohio

2.468
Subsequent to State enabling legislation, zoning, and subdivision, regulations are adopted at the county or local level. The county may initiate zoning in unincorporated territory of a township on its own initiative, or, upon receiving petitions from voters in the unincorporated area. The Board of County Commissioners can appoint a Rural Zoning Commission to prepare the regulations which, after public hearing, the Board may then approve. The zoning plan must be approved by the electorate residing in the unincorporated area. (2-63) County rural zoning regulations take precedence over township regulations unless the electorate votes to accept the latter. (2-63) According to the Ohio Revised Code, subdivision regulations may be applied to any unit of land divided into two or more parcels where one is less than five acres, and the use of which would involve improvements such as the widening or extension of existing streets, allocation of land for open space or the use of easements for the extension of public facilities. If the county (for unincorporated areas), village, or city has adopted a major plan for streets and open public ground, it has approval authority of plats of subdivision. The county may adopt rules and regulations for coordination of the subdivision with existing roads and for the amount of open space. It may also specify the construction of improvements. The Board of County Commissioners or legislative authority may also adopt regulations concerning performance or construction agreements or the furnishing of a performance bond. Ashtabula County has review authority for local zoning regulations, but has not adopted a separate set of regulations for approval of zoning in unincorporated areas. The latter authority has been left to the individual localities. The county has, however, expressed interest in an overall

approach to development. The county has a subdivision ordinance that is applied to areas that do not have one of their own. The county ordinance is pending revision; and the discussion below refers to the prospective new ordinance. The County Planning Commission reviews all subdivisions, including planned unit developments. This enables review by the Planning Commission, engineers, and Health Department of the suitability of proposed developments from the standpoints of transportation, schools, adequacy of water supply, and potential flooding. Also included in the proposed revision is possible review by Scenic River Councils or a Coastal Zone Management agency for subdivisions within their respective jurisdictions. (2-71) The proposed subdivision regulations include minimum lot requirements that apply to areas not covered by local zoning and may be applicable to zoned areas in conformance with the existing zoning. Multi-family, commercial, and industrial developments would be prohibited in areas without central sewage treatment with 20,000 square feet given as minimum lot sizes for single- and two-family residences with on-lot disposal. Thus, developers might have to install packaged or connecting sanitary sewage systems where sewer systems are not available and septic systems are not permitted. Streets and roads would also have to be provided in conformance with a county thoroughfare plan and road specifications. The street plan would be designed to prevent industrial traffic in residential areas and avoid generating traffic on local streets from commercial areas.

Pennsylvania

2.469
The Pennsylvania Municipalities Code (Act 247, 1968) (2-73) enables counties to adopt subdivision and zoning regulations for any cities, boroughs, incorporated towns, or townships that do not have such regulations. Localities adopting such regulations must send them to the county planning agency for review before enactment. Subdivisions are defined by the Erie County Subdivision Regulations to include any division of land into two or more parcels except when parcels are over 10 acres and sold for agriculture. (2-73) Subdivision ordinances may require a review of all plans and this review may include: coordination and compliance with the comprehensive plan; provisions governing the standards by which utilities and other improvements will be installed as a condition of plan approval; and provisions for flexible layout and design. Approval of subdivision plans is by either local governing boards or planning agencies, or by the counties. All plans for subdivisions must at least be reviewed by the county. Provisions governing mobile home parks must be separate article and regulation of "Planned Residential Development" (PRD) must be by a separate ordinance. The latter ordinances must regulate the uses permitted, including the type of dwelling, permissible nonresidential uses and standards governing the intensity of land use in

a Planned Residential Development. They may also require the setting aside of common open space. The local governing body has approval authority of PRD plans. The Municipal Planning Code enables zoning regulations to have, in addition to the classifications governing general uses and structures, classifications restricting or prohibiting uses or structures near bodies of water, flood plain areas, or places of relatively steep slope. An appointed zoning officer administers a zoning ordinance with appeal for a variance being heard by an appointed zoning board. Zoning changes must be approved by the governing body. However, such changes are reportedly quite common throughout the Regional Study Area. (2-74) Erie and Crawford Counties function largely as review and/or advisory agencies in the matters of land use management. They both have review functions for local ordinances and amendments. Both have adopted subdivision regulations that cover those municipalities that have not adopted their own. Neither has enacted a county-wide zoning code. The Erie County Subdivision Ordinance requires water and sewer plans, can require bonds to cover utilities and other improvements, and can prohibit development on certain lands, such as those subject to flooding. (2-73) The pavement of roads is required according to applicable specifications of the Pennsylvania Department of Transportation. Land for community facilities may be required if those available cannot handle population increases that may follow the new development in non-sewered areas or areas without accessible sewers. One of the following may be required: completed sanitary sewer systems; approval for on-lot sewage disposal by the Erie County Health Department; or capped sewer lines where there will be a sewer system in five years. Lot-size requirements are dependent upon whether or not an area is sewered and whether or not it has a public water supply. There is no separate county Planned Residential Development ordinance. Such developments are covered under "large-scale developments" which provide for cluster housing, and Planned Unit Developments (PUD's). The latter must be on at least five acres and provide a minimum of two acres for recreational use per 100 units. Half of the 24 Erie County localities in the Principal Study Area were covered by this regulation as of April, 1977. These include, among the Coastal Communities, East Springfield Borough, Platea Borough, and Girard Township. Cranesville Borough and Elk Creek and Conneaut Townships, all close to the proposed project site, are also covered by the County Ordinance. (2-75) Springfield Township and East Springfield Borough are expected to soon have subdivision ordinances and Cranesville Borough has begun work on one. Others in the area near the proposed site may soon adopt their own regulations, while Elk Creek Township and Platea Borough reportedly have not indicated any intention of doing so. (2-76)

2.470

Crawford County subdivision regulations, unlike the Pennsylvania Municipal Planning Code, define subdivision as the division of any

parcel of land into three or more lots. Requirements include: Engineer certification of individual on-lot water and sewer systems as well as plans for other improvements; lot sizes that meet existing zoning ordinances and on-lot sewage requirements with modifications for large-scale developments as the County Planning Commission approves; and pavement requirements following municipality or existing County standards. (2-77) According to the Crawford County Planning Director, these regulations are in substantial need of revision. (2-78) In the Crawford County portion of the Principal Study Area, over half of the municipalities do not have their own subdivision regulations and are covered by the County regulations. (2-78)

Local Government

Ohio

2.471

Kingsville Township and North Kingsville Village. Kingsville Township has been divided into Residential, Residential-Recreational, Agricultural, Commercial, and Special Use districts, all of which include residential development as permitted uses. Although large sections are zoned Agricultural, any land in the township that is five or more acres or derives 50 percent or more total income from farming may be considered as an agricultural parcel. The types of residential development permitted in other districts within the township are shown in Table 2-280. The Residential-Recreational district also permits uses that would require open space and are operated for profit. The Special Use districts are not delineated on the zoning map. They include those uses for which conditional zoning certificates can be awarded, such as light industry, sanitary landfills, and recreation. (2-79) The village of North Kingsville is divided into three zones: Residential, Commercial, and Light Industrial. The Residential Zone covers approximately 75 percent of the village and is reserved for one- and two-family dwellings, farms, truck gardens, parks and public and private community facilities. The Commercial Zone, about 10 percent of the village area, is confined to areas along major thoroughfares. Factories, manufacturing plants, and several types of storage yards are excluded from this zone. The Light Industrial Zone, about 15 percent of the village, is reserved for industry that can be operated without creating "objectional" dust, smoke, gas, fumes, vapors, odor or noise. (2-80) The local subdivision ordinance requires easements along each side of any stream or important surface drainage course and dedication (or reservation for public acquisition) of already-designated public areas that exist within the property being subdivided. Paved roads, water supply, storm drainage, and sanitary sewers must be provided by the subdivider. The ordinance indicates that individual septic tanks will not be approved except as a last alternative. When sewage

Table 2-280

Residential Development in Other Districts of Kingsville Township

Zone (District)	Minimum Lot Size[1] (Sq Ft)	Partial List of Permitted Residential Uses	Notes
Residential (R)	12,000-20,000	One- and two-family dwellings House trailers Structures for temporary residence for transient workers	
Residential-Recreational (R-R)	12,000-20,000	Structures for temporary residence of transient workers	
Commercial (D)	12,000-20,000	Apartment houses	
Special Use	12,000-20,000		Mobile home park Mobile homes Multiple housing unit (as conditional uses)

(1)Depending upon water/sewer facility availability.

Source: Kingsville Township Zoning Resolution.

treatment plants, water systems, park areas, or other facilities of the subdivision are not to be maintained by the municipality or some other public agency, that maintenance may be made part of the deed restrictions for lot owners in the subdivision. (2-81) North Kingsville's framework for land use management was reportedly being revised in 1977.

2.472
Ashtabula Township. The township of Ashtabula has two sets of zoning regulations: the first covers most of the township, including the area bounded by the city of Ashtabula, the Ashtabula River, and Lake Erie. The second covers the small area south of the city of Ashtabula and southwest of the Ashtabula River. The requirement for residential uses in the first area are listed in Table 2-281. About 40 percent of this area is zoned for these uses. As in Kingsville, agriculture is exempt from these regulations. The ordinance requires mobile home parks to be on a minimum of ten acres of land. There are three industrial zones (light, medium, heavy) which are distinguished by the level of performance standards required, with the very small light industrial zone being the most restrictive. The three industrial zones occupy about 55 percent of this area of the township, a higher percentage than in the other Ohio Coastal Communities. The small southwestern part of Ashtabula Township is divided into three zones with the residential use requirements shown in Table 2-282. The residential zones occupy about 85 percent of this part of the township, with the remainder zoned for light industry and commerce.

Ashtabula City

2.473
The city of Ashtabula has its own zoning and subdivision regulations. It is divided into 13 zones. Residential use requirements in these zones are summarized in Table 2-283. Residential zones occupy about 60 percent of the land area of the city. Commercial districts in Ashtabula City comprise about eight percent of the city's land area. The light industrial district (about seven percent of the city) is similar to but less restrictive than the central commercial district. The heavy industrial district (about 25 percent of the city) prohibits residential uses; industrial uses must not be in conflict with city ordinances regulating nuisances. As special uses, planned residential developments of any type require a minimum of five acres of land and minimum lot sizes consistent with the zone in which they are built. (2-82) Subdivisions regulations in the city of Ashtabula establish lot dimensions for new subdivisions that follow the maximum required in the R-1 district (7,500 square feet) regardless of existing zoning. An exception to this would be planned developments with "adequate park areas." (12,000-20,000 square-foot lots are required if no public sewer or no sewer or water supply facilities

Table 2-281

Residential Use Requirements in the First Area of Ashtabula Township

Zone (District)	Minimum Lot Size (Sq Ft)	Some Permitted Residential Use	Notes
Residential (R)	7,500-11,500 for one- and two-family houses (lot size for apartments varies with number of units)	One- and two-family dwellings (except mobile homes)	Apartment houses (as a conditional use)
Business (B)	7,500-11,000 for dwellings 4,000 for mobile homes	One- and two-family dwellings, trailers and mobile home courts	Apartment houses (as a conditional use)
Light Industrial (LI)	(Lot size varies with no. of units)		Apartment houses (as a conditional use)

Source: Ashtabula Township Zoning Regulations, Precincts 1, 3, 4, 5, 6, 8, 9.

Table 2-282

Residential Use Requirements in the Southwestern Portion of Ashtabula Township

Zone	Minimum Lot Size (Sq Ft)	Partial List of Permitted Residential Uses
Suburban Residential	12,000	One- and two-family dwellings (excluding trailer homes)
General Residential	12,000 (variable for multiple dwellings, depending upon size)	One- and two-family dwellings. *Multiple-family* dwellings

Source: Ashtabula Township Zoning Regulations, Precincts 2 and 7.

Table 2-283

Residential Use Requirements in Ashtabula City

Zone	Minimum Lot Size (Sq Ft)	Partial List of Permitted Residential Uses
R-1	7,500	Single-family dwelling
R-2	5,000	Single-family dwelling
R-3	2,500-5,000 (depending upon use)	Single- and two-family dwellings. Multiple-family dwellings
R-4, C-1, C-2 and M-1	1,000-5,000/unit (depending upon use)	One- and two-family dwellings and multiple-family dwellings
R-5 and M-3	600-5,000/unit (depending upon use)	One- and two-family dwellings and multiple-family dwellings

Note: The permitted residential uses in these zones as listed in Title Nine do not agree with the Ordnance, Title Seven, (1973 Replacement). It appears that corrections may not have been carried throughout the text.

Source: Codified Ordinances of Ashtabula, (1973 Replacement), Title Nine, pg. 60.

Table 2-281

Residential Use Requirements in the First Area of Ashtabula Township

Zone (District)	Minimum Lot Size (Sq Ft)	Some Permitted Residential Use	Notes
Residential (R)	7,500-11,500 for one- and two-family houses (lot size for apartments varies with number of units)	One- and two-family dwellings (except mobile homes)	Apartment houses (as a conditional use)
Business (B)	7,500-11,000 for dwellings 4,000 for mobile homes	One- and two-family dwellings, trailers and mobile home courts	Apartment houses (as a conditional use)
Light Industrial (LI)	(Lot size varies with no. of units)		Apartment houses (as a conditional use)

Source: Ashtabula Township Zoning Regulations, Precincts 1, 3, 4, 5, 6, 8, 9.

are available.) Easements along streams are also required by these regulations. Surfaced streets and sidewalks, storm drainage, water and sanitary sewer lines (where 300 feet or less from existing mains) are all required improvements. (2-83)

Saybrook Township. The township of Saybrook has been divided into five residential districts, two commercial districts, and several industrial districts and has reserved areas for recreation and research and development. Requirements in areas where residential dwellings are permitted are summarized in Table 2-284. Commercial districts for retail, personal, and motor services, prohibit manufacturing uses. There are varying degrees of restriction on the amounts of dust, odor, smoke, or noise emitted from industrial areas with breweries, oil refineries, refuse dumping, explosives manufacturing, and rubber reclamation examples of prohibited activities. The various activities described above may also be grouped into industrial parks. Planned Unit Developments (PUD's) are permitted in any of the zoned districts provided they are compatible with existing uses. Township requirements for PUD's such as 10-40 acre minimum areas (depending on uses) with 20 percent of the land reserved for common open space, are in addition to applicable county subdivision regulations. (2-84)

Pennsylvania

2.474
Girard (Girard Township, Lake City, and Girard Boroughs). Girard Township passed a new zoning ordinance effective 8 March 1977, and had no subdivision regulations as of April 1977. (2-75) The code requires one-acre minimum lot size for Rural Residential and Agricultural zones, which previously made up 76 percent of the total land area. Another 17 percent was zoned for suburban residential use, where minimum lot sizes are conditioned on the availability of water and sewer infrastructure. The remaining acreage is part of the Business District, which also allows residential uses with similar requirements to those in the Suburban Residential District. (2-85) Lake City Borough has both zoning (2-86) and subdivision ordinances. (2-87) Thirty-eight percent of the Borough is zoned for light industry, which includes retail and wholesale business and one area is zoned for an industrial park "A"-type residential zones are designed for single-family dwellings with minimum lot size of 9,000 square feet, except where on-lot sewers are used. Trailer houses of any type are prohibited in this zone. Single- and multiple-family houses are the principal uses allowed in other residential areas, with less restrictive lot acreage requirements. There is a trailer and mobile home district for single trailers and parks, where not more than 20 percent can be devoted to transient vehicles (defined as up to five months in residence). Trailer parks must be a minimum of

Table 2-284

Residential Use Requirements in Saybrook Township

Zone	Minimum Lot Size (Sq Ft)	Partial List of Permitted Residential Uses
Residential (R-1)	7,500-20,000 (depending upon water, sewer facility availability)	One- and two-family detached dwellings, Summer dwellings
Residential and Agricultural (R-2)	"	Agriculture, one- and two-family dwellings
Resort Area (R-3)	"	Resort residences
Multi-Family (R-4)	10,000 (w/public water and sewer facility availability)	One- and two-family residences, multi-family residences
Mobile Home Parks	7,500[1] (w/public water and sewer facility availability)	Mobile homes (park must be a minimum of 10 acres)
Commercial (C-1)	7,500-20,000 (depending upon water/sewer facility availability)	One- and two-family dwellings, apartment buildings
Industrial (I)		One- and two-family dwellings, no platting for residential purposes
Research and Develop Development (R&D)		One- and two-family detached dwellings, no platting for residential purposes

(1) This figure is from Article Three; Article Ten lists 4000 square feet as a minimum. Changes may not have been corrected throughout the text of the plan.

Source: General Zoning Plan, Township of Saybrook, Ohio, 1973.

five acres, connect to public water and sewer systems, and devote at least 10 percent of the total area to recreation. Temporary permits may be authorized for one year for nonconforming uses incidental to construction and housing projects. Under the subdivision regulations, utility and road improvements must be installed or a performance bond filed. Lands subject to flooding or "other unsuitable conditions" cannot be used for residential uses. Primary streets must be designed by the Borough Engineer and pavement should be planned on all streets. (2-86) The Erie County Planning Department has suggested an update of this ordinance. (2-66) The requirements for residential uses in Lake City are listed in Table 2-285. In Girard Borough, 78 percent of the area is zoned low-density residential for single-family dwellings, with a minimum lot size of 7,500 square feet. (2-88) One percent of the borough is zoned high-density and allows apartment houses. All three residential areas allow planned residential developments as conditional uses subject to review by the Planning Commission and approval of the governing body. Six percent is zoned for light manufacturing and three percent for commercial uses. There is a flood plains zone around Elk Creek with few standards to regulate its use. (2-66) There is also a 50-foot setback requirement and a prohibition against disturbing the natural vegetation associated with any natural drainage course. Provisions concerning residential uses in flood areas and utility and road improvements are similar to the Lake City regulations. (2-89) Table 2-286 lists the requirements for residential uses in Girard Borough.

Fairview (Township and Borough)

2.475
Fairview Township has made a commitment to maintaining its rural character. (2-66) Thirty-one percent is zoned rural residential and 25 percent is zoned agricultural. A special district (five percent of the acreage) protects Elk and Walnut Creeks with a few land-use types being allowed as "special exceptions." Twenty-three percent is zoned for suburban residential uses. Several industrial park designations take up 10 percent, four percent is neighborhood commercial and the remaining two percent is zoned as highway commercial. A set of comprehensive land subdivision regulations has also been adopted. The requirements for residential uses in Fairview Township are summarized in Table 2-287. Fairview Borough revised its zoning ordinance to reflect changes in its Comprehensive Plan. At present, 76 percent is zoned suburban residential, six percent is allocated for urban residential use, and 10 percent for business/community shopping. There is a single industrial park area that takes up eight percent of the Borough's acreage. (2-66) Residential use requirements in Fairview Borough are shown in Table 2-288. Mobile home parks must allocate eight percent of the park acreage for recreational use. The Industrial Park district excludes those processes which produce pollutants that represent health or safety

Table 2-285

Residential Use Requirements for Lake City Borough

Zone	Minimum Lot Size (Sq Ft)	Partial List of Permitted Residential Uses
R-A	9,000-12,000 (depending upon water/sewer facility availability)	Single-family dwellings
R-B	7,500-20,000 (as above) Multi-family - 12,500 (2000 sq ft/ family for each additional family over two)	Single-family Multi-family Approve apt. buildings
R-C	5,000	Mobile homes Travel trailers, campers, etc. Travel and mobile home parks

Source: Lake City Code, Chapter 72, Zoning.

Table 2-286

Residential Use Requirements for Girard Borough

Zone	Minimum Lot Size (Sq Ft)	Partial List of Permitted Residential Uses	Notes
R-1	7500	Single-family dwelling	
R-2	7500 (min lot/ fam - 3500)	Single- and two-family dwellings	Planned unit dev. as conditional use
R-3	7500 (min lot/ fam - 3500)	Single, two and multi-family developments	Planned unit dev. as conditional use

Source: Ordinance Number 468, Zoning Ordinance, Borough of Girard.

Table 2-287

Residential Use Requirements for Fairview Township

Zoning District	Permitted Uses	Minimum Lot Area (Sq Ft) No Sewer	Minimum Lot Area (Sq Ft) All Utilities	Minimum Yard Sizes (Ft) Front	Minimum Yard Sizes (Ft) Side Total/One	Minimum Yard Sizes (Ft) Rear	Minimum Lot Coverage (%)	Minimum Street Widths (Ft) Cart-Way	Minimum Street Widths (Ft) Right-Of-Way	Open Space (%)
R-1 Rural Residential	Single-family detached	20,000	10,000	35	24/10	40	35%	Minor: 30	50	10%
R-2 Suburban Residential	Single-family detached	20,000	10,000	35	24/10	40	35	Collector: 36	60	10
R-3 Urban Residential	Single-family detached	20,000	10,000	35	24/10	40	35	Arterial: as prescribed by the Penn. Dept. of Trans.		10
	Multiple-family	Not Allowed	10,000 plus 4000 for each unit 1	35	50/20	60	35			10
A Agricultural	Single-family detached	43,560	43,560	40	50/20	70	30			10
	Mobile homes (in a mobile home park)	Not Allowed	6,000	20	24/10	25	-			8
S Special	Single-family detached	43,560	43,560	35	50/20	50	30			10

Source: Fairview Township Zoning Ordinance.

Table 2-288

Residential Use Requirements in Fairview Borough

Zone	Minimum Lot Size (Sq Ft)	Partial List of Permitted Residential Uses	Notes
R-S (Suburban Residential)	10,000-20,000 (depending upon type of housing)	Single-family detached Single-family attached (max. 2 units) Single-family pre-fabricated Single-family group housing	Agricultural activities on a minimum of 2 acres are a special exception. Single-family group housing is subject to conditional use review.
R-U (Urban Residential)	6,000-20,000 (depending upon type of housing)	Single-family detached Single-family attached (max. 2 units) Multi-family housing (6 units/structure) Single- and multi-family group housing	Single- and multi-family housing is subject to conditional use review. Mobile home parks are a conditional use (3 acres min for a park).
C (Business - Community Shop.)	8,000	Dwelling units above commercial establishments	As a special exception

Source: Zoning Ordinance for the Borough of Fairview, Erie County, Pennsylvania, December, 1974. Prepared by Michael Baker, Jr., Inc.

hazards to the community as determined by the Planning Commission and Zoning Hearing Board. Other types of industry, which may be considered as conditional uses, include paper, fertilizer, and gas manufacturing, and petroleum storage. (2-90) The subdivision ordinance for Fairview Borough may further require that a project sanitary sewer system be built if access to a public sanitary sewage system is not available. The ordinance requires a subdivider to provide a public water system for development of 25 units or more. Furthermore, it may be required that up to 10 percent of the property be dedicated or reserved for parks or recreation if such facilities are included in the Comprehensive Plan. A lot fee, in lieu of such property, may be substituted and used for the purchase of recreational lands elsewhere. (2-91)

2.476
Millcreek Township. Millcreek, the closest township to the city of Erie, has five residential zoning designations. (2-92) The "A"-type residential zones for single-family dwellings on a minimum of 7,200 square feet make up 30 percent of the township acreage. Agricultural districts also have a minimum lot size of 7,200 square feet for a single-family dwelling, and 31 percent of the township is zoned agricultural. Mobile home courts, along with public playgrounds, are restricted to a single, small district (less than one percent), where other types of residences are prohibited. Two percent of the area is zoned for multiple dwellings and apartment houses. Business districts fall into four zones taking up five percent of the total area. Seventeen percent is zoned for light industry and six percent for heavy industrial uses. In both, uses which have "offensive levels of dust, smoke, gases, direct, noise, vibrations, odors" are prohibited, but these levels are not defined. Coke ovens, petroleum refining, manufacture of "deadly chemicals," and refuse storage or dumping are some examples of prohibited uses. Millcreek subdivision regulations (2-93) include requirements for improvements. In addition, a subdivider must gain development approval from the Township Engineers and Supervisors as well as certification by the Erie County Health Department for on-lot sewage disposal. Natural drainage easements conforming to the line of water course, and of adequate width to prevent flow restriction, are required. Cash deposits to guarantee the control of storm drainage and/or erosion during construction, and in lieu of possible damages, as well as temporary vegetative cover for areas exposed over 60 days, are also required. Utility and road improvements may be required by the Township Supervisors in addition to those in the ordinance. The Trustees may also require that the county or state approve water supply or sewage plans. Millcreek has separate mobile home and Planned Residential Development ordinances. The requirements for residential uses in Millcreek Township are presented in Table 2-289.

Table 2-289

Residential Use Requirements in Millcreek Township

Zone	Minimum Lot Size (Sq Ft)	Partial List of Permitted Residential Uses
Agriculture	7200	One-family dwelling (agri.)
A-Residential	7200	One-family dwelling
B-Residential	4800	One- and two-family dwellings
C-Residential		Mobile home courts
D-Residential	1,600-2,800	Multiple dwellings Rowhouses Apartments

Source: Zoning Ordinance of Millcreek Township, Erie County, Pennsylvania, Ordinance No. 74-79, December 30, 1974.

Crawford County

2.477
In the Crawford County portion of the Principal Study Area, 81 percent of the 16 localities have met the requirement for Federal flood insurance, but only 39 percent have zoning regulations and 44 percent have subdivision ordinances. Those without ordinances include Beaver Township, Conneaut Township and North, South, and West Shenango Townships. West Shenango is the only one with a subdivision ordinance. (2-69) These communities are south of the proposed project site and on or near the Pymatuning Reservoir. Two communities which have recently received substantial assistance from the County Planning Commission are Woodcock and Richmond Townships. Woodcock Township is divided into eight zones (2-94), but most space is taken up by agricultural and rural residential use districts. Streams are surrounded by flood plain zones and Woodcock Creek Lake is bordered on all sides by a large conservation open-space zone. Public utility structures such as buildings, treatment plants, and principal overhead transmission lines are examples of conditional uses in all districts except the general industrial districts. All Planned Residential Developments must be approved under a separate ordinance.

2.478
The agricultural district is designed to protect prime agricultural and forest land, based on soil classifications. As such, the minimum lot area is 50 acres for each residential structure in this zone, except for additional residences associated with farming activity or inhabited by relatives of the occupants of the principal residence. In addition, the owner of 99.9 acres or less may subdivide, as a special exception, one area for rural residential use. This action has a minimum requirement of three acres per building. The maximum number of special exceptions is three subdividisions for a farmer with 150 acres or more. Furthermore, the land may not be subdivided again, even if it is sold. Rural Residential Districts permit single-family, two-family detached, mobile, and modular homes as well as Agricultural and Planned Residential Developments on three-acre minimum lots. Travel-trailer parks are a conditional use. The General Residential District permits all the above uses and public buildings on 7,200 square-foot sewered lots. Mobile homes are required to have a similar appearance to other dwellings and mobile home parks are a conditional use in this district. The permitted uses in the General Business District include planned residential developments with other commercial uses. The General Industrial District is basically for light industry with "heavy industry" (iron and steel foundry as an example) and incineration and sanitary landfills as conditional uses. Performance standards against "undue air, noise and water pollution" (in addition to DER permits) can be reviewed by specialists. The general flood plain area is reserved

for agriculture, loading, and vehicle parking for industries, recreation, and lawns and gardens. However, special exception permits may be obtained in this area. The Open Space District allows parks, agriculture, and stables. The proposed zoning ordinance for Richmond Township (2-95) is similar to that of Woodcock Township, but is more protective of agriculture. The Agricultural District, with 50-acre minimum lot sizes, has regulations similar to those listed above. Special exceptions provide for residential units on three-acre lots in areas of this zone that are not prime agricultural land. The rest of the township would be divided into Rural Residential districts and Development districts consisting of a core and fringe area. The core would contain mostly commercial uses. Planned Residential Developments are allowed in these last three districts, with plans reviewed under a separate ordinance. In both the Woodcock and proposed Richmond Township ordinances, conditions for variances are quite explicit, requiring that any issued variances protect the character of the zone in which they are being requested. The requirements for residential uses in the Woodcock Township and proposed Richmond Township Zoning Ordinances are shown in Tables 2-290 and 2-291, respectively.

The Local Study Area, Including the Proposed Site

a) Physical Characteristics

Conneaut City

2.479
A 1977 study reports a total acreage in Conneaut City of 16,330 consisting of 75 percent (12,239 acres) vacant or agricultural/rural land, and 10 percent (1,680 acres) residential (2-96). This compares with a 1965 study showing 77 percent vacant/agricultural/rural and 9.4 percent residential, indicating a very gradual trend toward urban growth. Most residential development in the city is compact, and includes a large number of older homes. Current land use data for Conneaut is presented in Table 2-292. Commercial areas in the city are generally small and lack the diversity found in larger shopping areas. Throughout the Regional Study Area, urban portions of the strip development and mixing of land use are prevalent in Conneaut City. In 1965, this was considered to be a serious problem for the future growth patterns. (2-97) The future growth of the city is restrained by the lack of an expanded sewer network and the topography of the area. Three railroads, I-90, and Conneaut Creek crisscross the area and cause divisions within the city. These factors combine to make the southern and western portions of the city likely future growth areas, contingent on expansion of the sewer network.

Table 2-290

Residential Use Requirements in Woodcock Township

Zone	Minimum Lot Size	Partial List of Permitted Residential Uses	Notes
A-1	50 acres	(agriculture) Single- and 2-family detached dwellings Mobile homes, modular homes	
R-1	3 acres	(agriculture) Single- and 2-family detached dwellings Mobile/modular homes Planned residential developments	Trailer parks are conditional use.
R-2	7,500-20,000 sq ft depending upon use and public sewage/water facility availability)	(no agriculture) Single- and 2-family	Trailer parks are conditional use.
B-1	Same as R-2--must be sewered sq ft 3-12,000/depending upon use. Single-family detached require min of 3000)	(agriculture) PUD	Trailer parks are conditional use.

Source: Zoning Ordinance Number 10, Woodcock Township, Crawford County, Pennsylvania, May 1976.

Table 2-291

Proposed Residential Use Requirements in Richmond Township

Zone	Minimum Lot Size	Partial List of Permitted Residential Uses	Notes
A-1	50 acres	(agriculture) Single-family and 2-family detached dwellings Mobile/modular homes Seasonal dwellings	
R-1	3 acres	(agriculture) Single-family and 2-family detached dwellings Mobile/modular homes Seasonal dwellings Planned Residential Development	Trailer parks as conditional use.
CD-1	4,000-15,000 sq ft (depending upon public sewage facility availability and use)	(agriculture) Single-family and 2-family detached dwellings Mobile/modular homes PRD Single-family attached dwellings	
ZD-1	4,000-15,000 sq ft (depending upon public sewage facility availability and use)	(agriculture) Single-family and 2-family detached dwellings Modular homes and double or triple wide trailers Single-family semi-detached	Trailer parks as conditional use.

Source: Draft of Proposed Zoning Ordinance, Richmond Township, Crawford County, Pennsylvania, February 1977.

Table 2-292

Comparison of Reported Existing Land Use in Conneaut - 1977 and 1978

Land Use Category	1977 Acres	1978 Acres	Percent of Total Area 1977	Percent of Total Area 1978
Residential	1,680	2,446	10.3%	14.6%
Commercial	86	276	0.5	1.6
Industrial	791	122	4.8	.8
Public*	1,533	1,418	9.4	8.4
Total Developed Land	4,090	4,262	25.0%	25.4%
Vacant or Agricultural Land	12,239	12,508	75.0%	74.6%
TOTAL	16,330	16,770		

*Public Land includes Service, Cultural, Entertainment and Recreation, and Transportation categories for 1978 revised statistics.

Sources: 1977 Figures - "Conneaut, Ohio: Housing and Land Use Study," Eastgate Development and Transportation Agency, modified by Arthur D. Little, Inc.

1978 Figures - Conneaut Planning Agency

Springfield Township and East Springfield Borough

2.480
The distribution of land use in the Pennsylvania Local Study Area for 1971 and 1975 is shown in Tables 2-293 and 294, respectively. Residential land use represents about four percent of total land use in the Springfield area, and is concentrated in East Springfield Borough and West Springfield. Based on a population of 3,288 persons and 1,032.11 acres of residential land in 1975, the density was determined to be 3.19 people per residential acre. Commercial, industrial, and institutional land uses are minor in the area. Commercial establishments, totalling 40 throughout the community, comprise 42.25 acres. These establishments follow the pattern of residential developments and are evenly dispersed. Industrial development is nonexistent in this area, but one-fifth of the land area is owned by U.S. Steel and its subsidiary, the Bessemer and Lake Erie Railroad. Institutional land use in the Springfield area amounts to 66 acres comprising 0.17 percent of the township and 1.3 percent of all land in the borough. The second largest land use in the Springfield area is recreational, more than 75 percent of this land is wooded or otherwise undeveloped. Most of the land in Springfield is agricultural and undeveloped. The incidence of dairy and fruit farming is attributable to the relatively mild lake plain climate and the degree of prime agricultural soils (as reported by the Erie County Planning Commission) available in the area. These soils bisect the area in a northeast/southwest direction. Without central sewage treatment and water supply, much of the undeveloped land is limited in its capacity to support agricultural or residential development because of the high water table and soil unsuitable for on-lot sewage disposal. The Springfield region is traversed by a number of railroads and highways. The railroads, Conrail, N&W and B&LE cross the region in an east-west direction. Following the same direction, I-90, US 20, and State Route 5 are the major highways. US 6N and State Route 215 run in a north-south direction.

The Proposed Project Site

2.481
The proposed project site is contained within some 5,500 acres of contiguous land owned by the applicant and its subsidiaries, (i.e., B&LE Railroad and the P&C Dock Company). About one-third of the area is within the limits of the city of Conneaut, with the remainder in Springfield Township. (refer to Figure 2-53) The character of the site is essentially rural/agricultural, with the exception of about 550 acres in the northwest portion presently in industrial use (or being prepared for use) by the B&LE Railroad and the P&C Dock Company for raw materials storage. Table 2-295, based upon a 1977 inventory of the site vegetation, presents the relative distribution of land

Table 2-293

Distribution of Land Use in Springfield Twp -- 1971 and 1975

Land Use Category	1971 (1) Acres	%	1975 (2) Acres	%
Residential	809	3.7%	876	4.2%
Commercial	30	0.1	37	0.2
Industrial	0	-	135	0.6
Public & Semi-Public	425	2.0	41	0.2
Recreation	0	-	132	0.6
Agricultural and Undeveloped	19,317	89.5%	18,819	89.8
Transportation	1,011	4.7%	914	4.4
Total	21,592	100%	20,954	100%

Source: (1) "Summary and Guide to Action," Erie Metropolitan Planning Department, p. 58.

(2) "Land Use Update Report, 1975," Erie County Planning Commission, Erie Metropolitan Planning Department.

Table 2-294

Distribution of Land Use in East Springfield Borough -- 1971 and 1975

Land Use Category	1971 Acres	1971 %	1975 Acres	1975 %
Residential	133	6.0%	155	7.0%
Commercial	3	0.1	3	0.1
Industrial	0	-	0	0
Public & Semi-Public	23	1.0	32	1.5
Recreation	0	-	0	-
Agricultural and Undeveloped	1963	88.4	1916	87.1
Transportation	98	4.4	94	4.3
Total	2220	100%	2200	100%

Source: "Northwest Area Profile, a Baseline for the Future," 1977 and "Land Use Update Report," Erie County Planning Commission, 1975.

Table 2-295

Distribution of Land Use on the Proposed Site -- 1977

	Acres	%
Trees	2199	40.4%
Shrubs	2395	44.0
Herbs	315	5.8
Developed or Under Construction	533	9.8
Total	5442	100%

Source: Aquatic Ecology Associates, *Summary Report*, July 15,1977.

types on the site. Only 76 acres (less than one percent) of the site were cultivated in 1977. Most of the remainder is in various successional stages following the cessation of cultivation five-20 years ago. Wetland areas are shown in Figure 2-54. Recent purchases by U.S. Steel have essentially completed the acquisition of private acreage within the contiguous areas shown on Figure 2-53, and recent construction activities of the B&LE Railroad and P&C Dock Company have restricted public access to portions of the site. Several of the bungalow-type summer cottages along the lakefront were rented to private individuals by the applicant during the summer of 1977. These leases were terminated on 31 March 1978. Use of areas adjacent to the proposed site include public recreation (Raccoon Creek County Park) immediately to the northeast, rural residential/commercial (to the south, between the site and Routes 5 and 20), suburban residential/commercial (to the southwest between the site and Route 20), and urban residential/commercial (to the west of the P&C Dock Company operation and Conneaut Creek). Consideration of the historic and archaeological values of the Lakefront site is presented in the section on potential land use constraints.

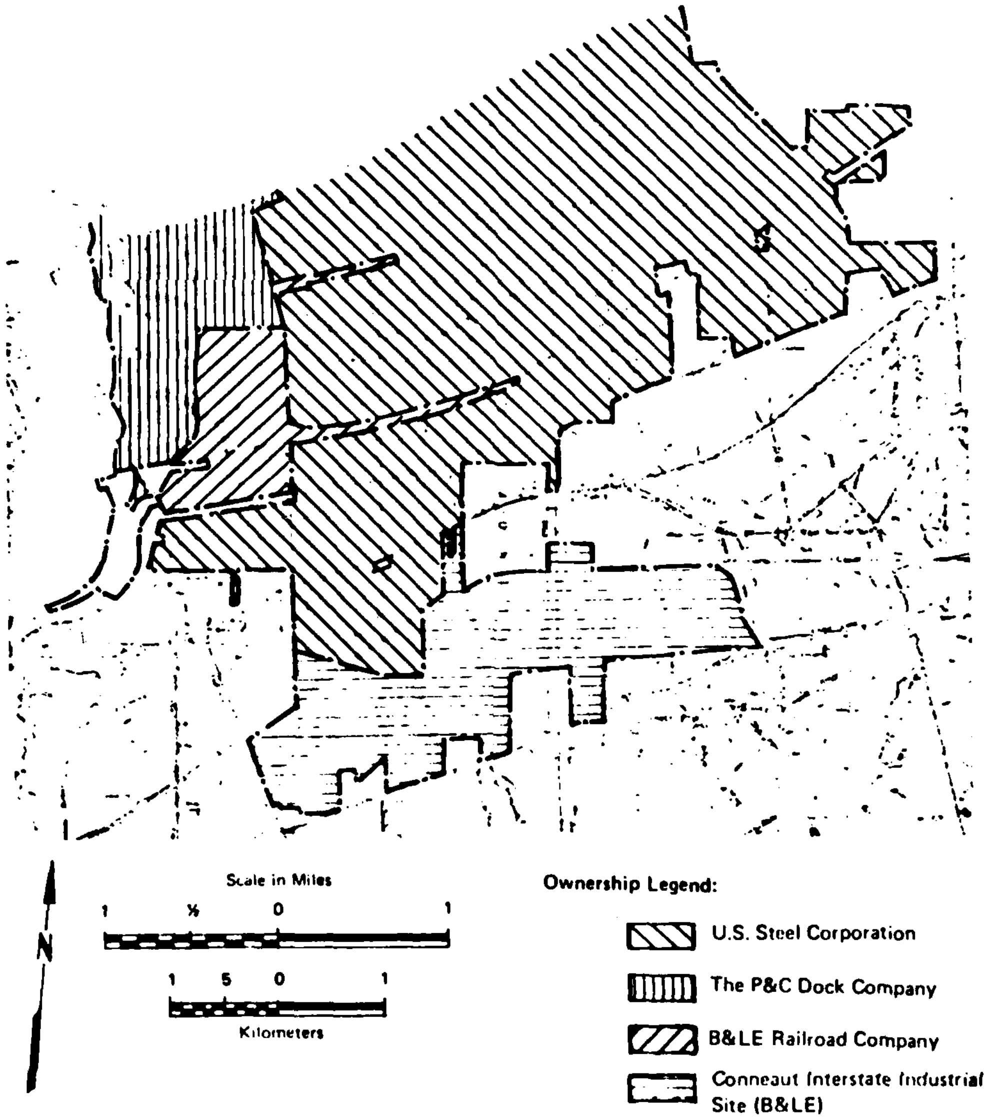
b) Institutional Characteristics

General

2.482
Conneaut City and Springfield are in the same Federal Air Quality Control Region (AQCR), and many of the limits for additional allowable emissions apply to both. The level of attainment of National Ambient Air Quality Standards (NAAQS) in any portion of the region can control the degree to which new sources can add to air contamination, and, in the extreme, can control the siting of new sources within the AQCR.

Conneaut City

2.483
Conneaut has 13 use zones that divide the city as shown in Table 2-296 and as illustrated in Figure 2-55. The requirements for residential uses in the city are shown in Table 2-297. The Special Use District is essentially reserved for recreation and park uses and is located both on the lake and along Conneaut Creek. The bulk of the Agricultural District which allows single-family dwellings is south of I-90. There are three major blocks of property zoned "R-1" for single-family residences on lots of 15,000-30,000 square feet (depending on infrastructure availability). One is along Lake Erie, and two border Conneaut Creek. The four areas zoned "R-2," urban residential, are also for single-family dwellings but on less acreage. The remaining urban residential districts are in and around



Source: United States Steel Corporation 1977.

FIGURE 2–53 PROPERTIES OF U.S. STEEL AND SUBSIDIARIES, INCLUDING THE PROPOSED PROJECT SITE

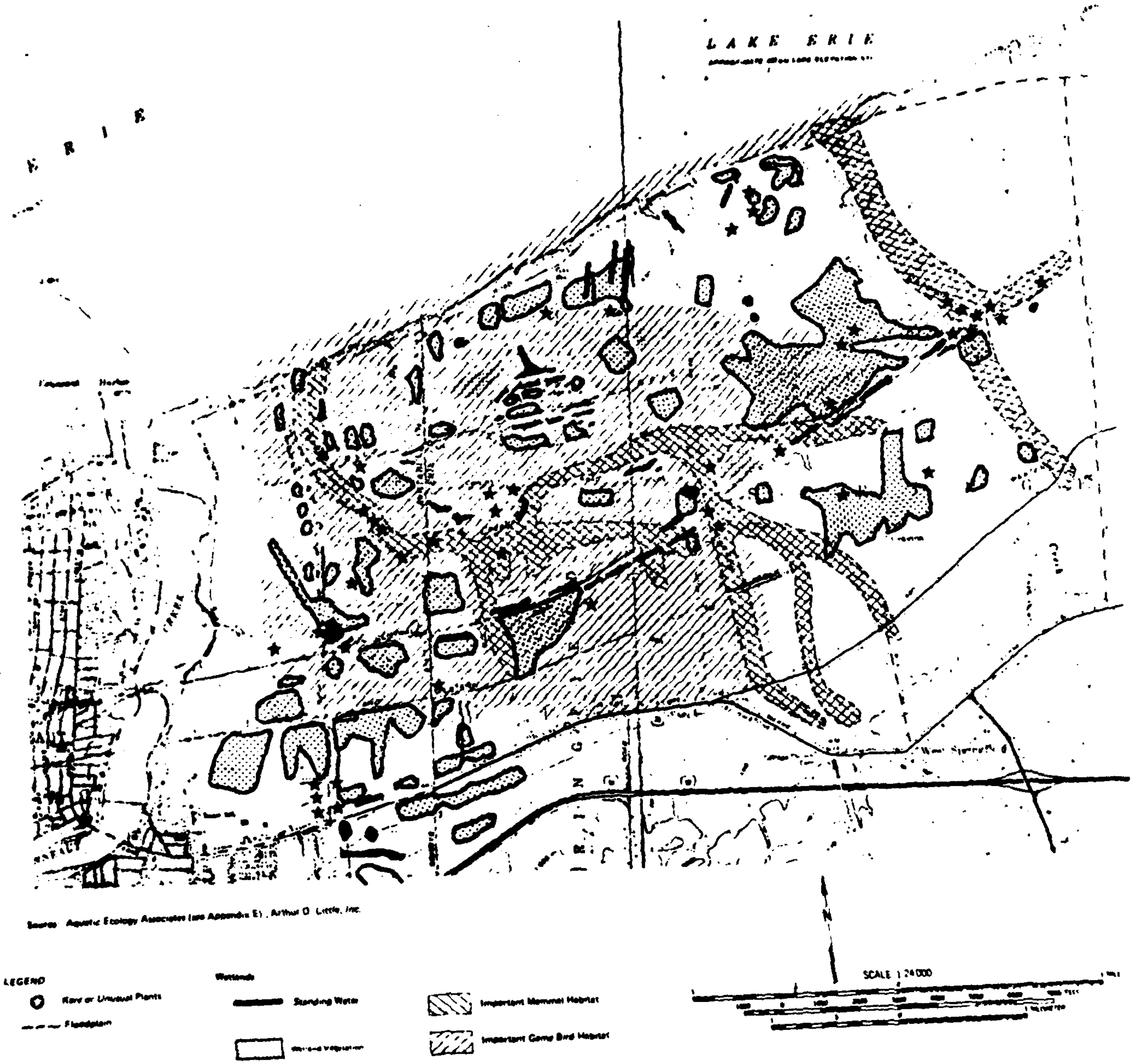


FIGURE 2–54 ENVIRONMENTALLY SENSITIVE AREAS ON THE PROPOSED PROJECT SITE

Table 2-296

City of Conneaut Land Use Zones

	Zones	Approximate % of City Land Area
S-1	Special Use	9%
A-1	Agricultural	27
R-1	Suburban Resident	4
R-2	Urban Residence	6
R-3	Urban	32
R-4	Urban	2
R-5	Seasonal Residence	1
B-1	Neighborhood Bus.	less than 0.1
B-2	Neighborhood and Comm. Bus.	4
B-3	General Business	less than 1
M-1	Restricted Industry	2
M-2	Industry	less than 1
M-3	Heavy Industry	12

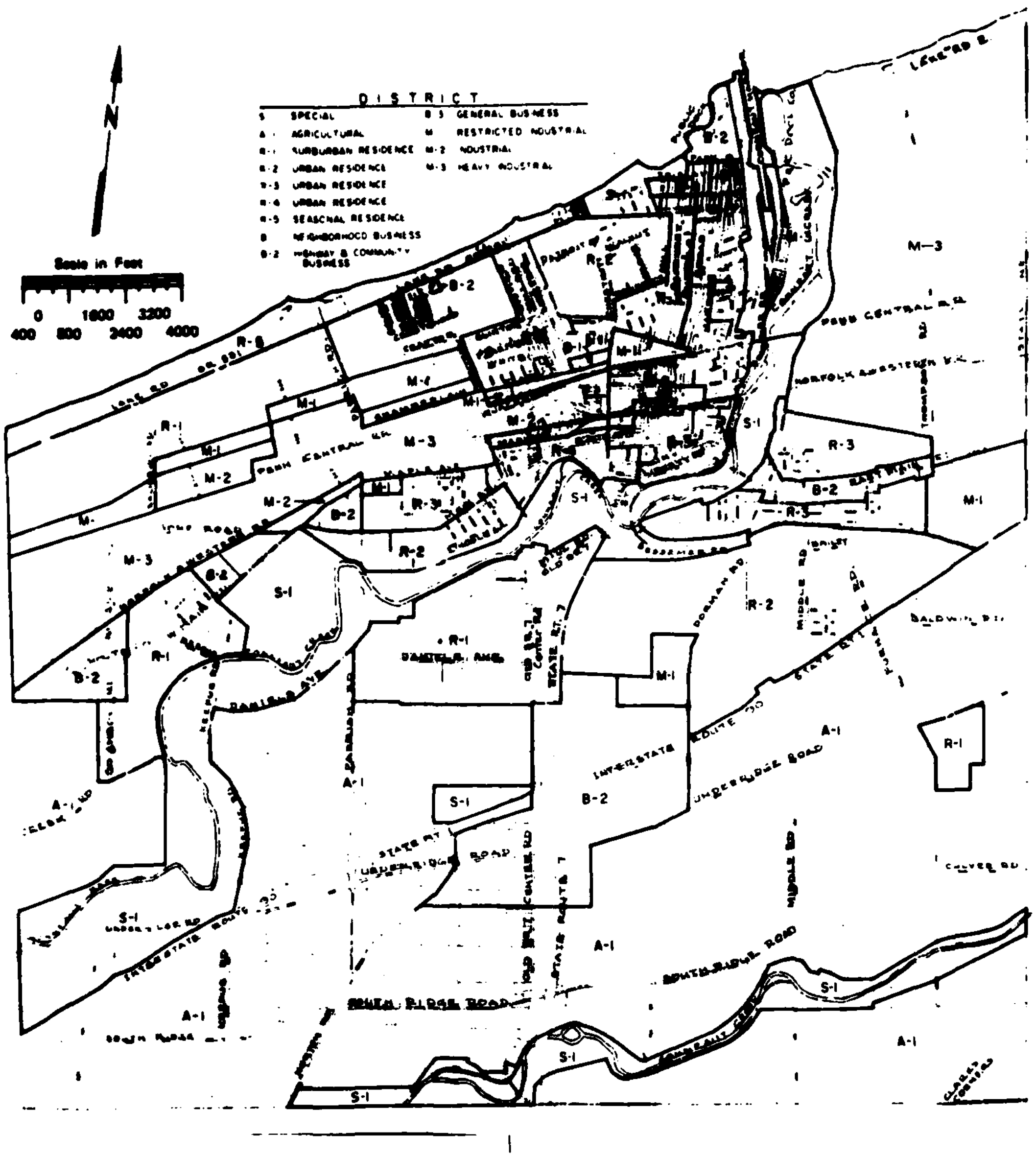
Source: Official Zoning Map, City of Conneaut.

Table 2-297

Residential Use Requirements in Conneaut City

Zone	Minimum Lot Size	Partial List of Permitted Residential Uses	Notes
A-1	Farm Dwellings (10 acres) Dwellings 15,000-30,000 sq ft (Depending upon public water/sewage facility available)	Farm dwellings Single-family residences	Planned Residential Development as conditional use
R-1	15,000-30,000 sq ft (depending upon public water/sewage facility availability) (5 acres for raising domestic animals)	Single-family residences	Planned Residential Development as conditional use
R-2	12,000 sq ft	Single-family residences	(as above) and limited agriculture.
R-3	6,000-7,500 sq ft (depending upon use)	One-family residences Two-family residences	PRD as conditional use
R-4	1,500-5,400 sq ft (depending upon use)	One-family residences Two-family residences Multi-family residences	PRD as conditional use PRD as conditional use PRD as conditional use
R-5	15,000-30,000 sq ft (depending upon public sewage/water facility availability) seasonal - 3,000 sq ft	Single-family residences Seasonal residences	PRD as conditional use PRD as conditional use
B-1	- -	Multi-family dwellings	
B-2	- -	Multi-family dwellings	Trailer parks as conditional use.

Source: Land Planning and Subdivision Regulations for the City of Conneaut.



Source: Conneaut City Planning Commission.

FIGURE 2–55 ZONING MAP OF CONNEAUT

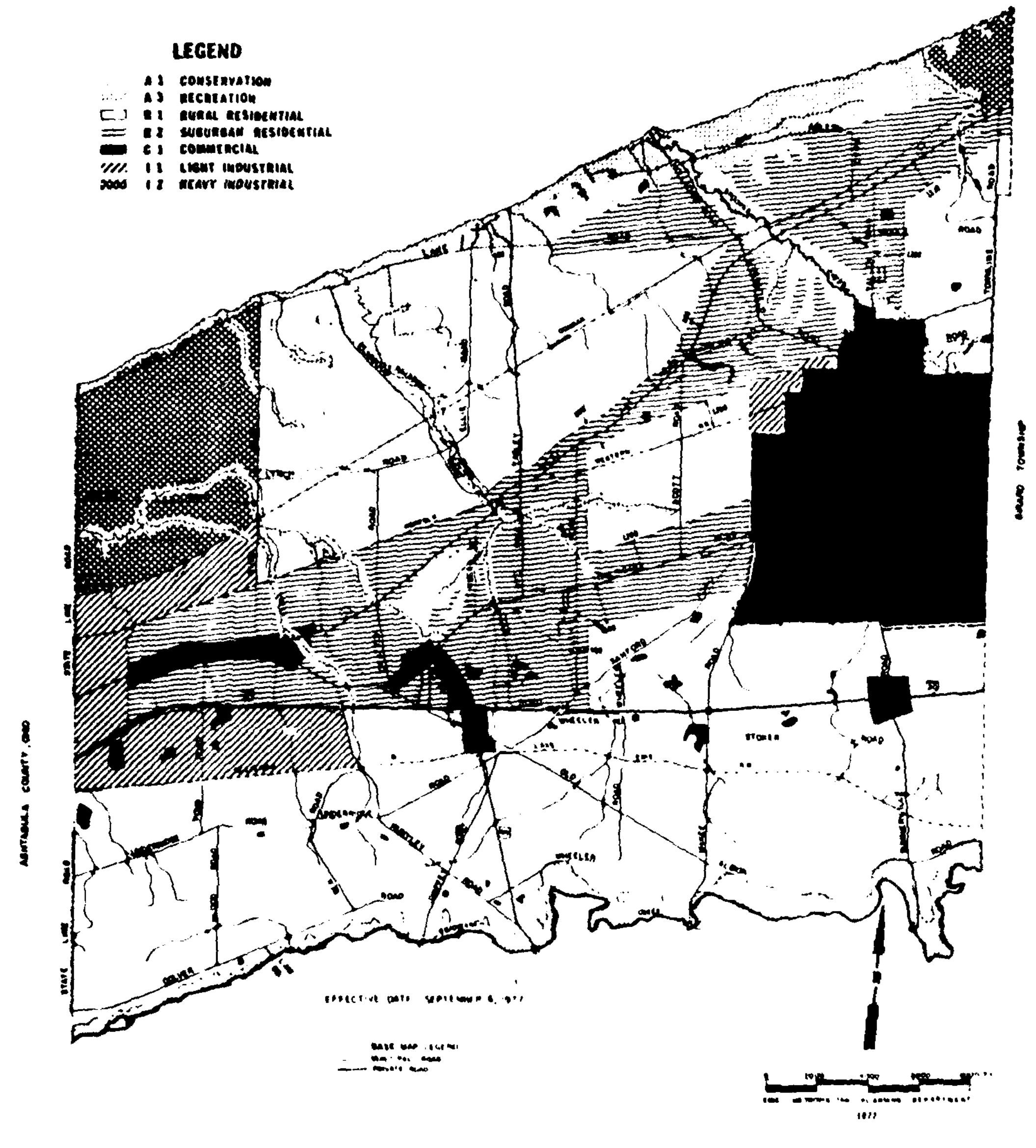
the center of town, clustered near the mouth of Conneaut Creek. These allow for single and two-family dwellings with multi-family dwellings being restricted to the higher-density zone. The major use permitted on the R-5 district is seasonal cottages. (2-98) Planned Residential Developments are conditionally permitted in all five residential zones, subject to Zoning Commission approval. The minimum lot size is 10 acres, the average lot size per dwelling cannot be reduced more than 10 percent of the zone standard, and at least one out of every 10 acres must be allocated for recreational open space. (2-98) Integrated Planned Developments and Commercial Developments are also conditionally permitted in all five zones. The major business districts are along US-20, I-90, and in the center of town. Tourist parks including house trailers, are conditionally allowed in these zones. (2-98) In the districts zoned for industry, almost all uses are conditional and required to comply with a set of Performance Standards. Typical examples include railyards, finished equipment assembly plants, and merchandise storage in M2 or M3 zones. An affidavit of compliance with these standards must accompany applications for zoning or building permits for new sources. Measurements of compliance can be made at the boundary with any "R" district. Performance standards include limits on noise (in M-3, 85 decibels at property boundary or in an adjacent "R" district) smoke (not darker than No. 3 on Standard Ringleman Chart, with exception), odors, air pollution that "can cause damage to the health or forms of property," and glare. (2-98) The proposed project site in the northeastern portion of Conneaut was reportedly rezoned from A-1 to M-3 in 1972 for tax revenue purposes. (2-99) Subdivision regulations provide the city with review and approval authority for development plans. Paved streets and utility improvement (where applicable) and lands for public use are required. Completed improvements or performance bonds, and a deposit to serve as a maintenance guarantee for all such improvements are also required. (2-100)

Springfield Township and East Springfield Borough

2.484
Springfield Township is different in character from Conneaut City. It is rural, and has no public water or sewage systems. The township borders Lake Erie and contains portions of three lake tributaries: Turkey Creek, Raccoon Creek, and Crooked Creek. Conneaut Creek forms its boundary with Conneaut Township. The flooding liability of these creeks and/or bluff erosion potential could be cause for increased protection of parts of the township through the Pennsylvania Coastal Zone Management Program, but no specific measures have been formally proposed. (2-68) Crooked Creek and its watershed is subject to more stringent water quality requirements than the others, as it is a "conservation stream" under the Pennsylvania Sewage Facilities Act. (2-101) Springfield Township passed new zoning regulations in

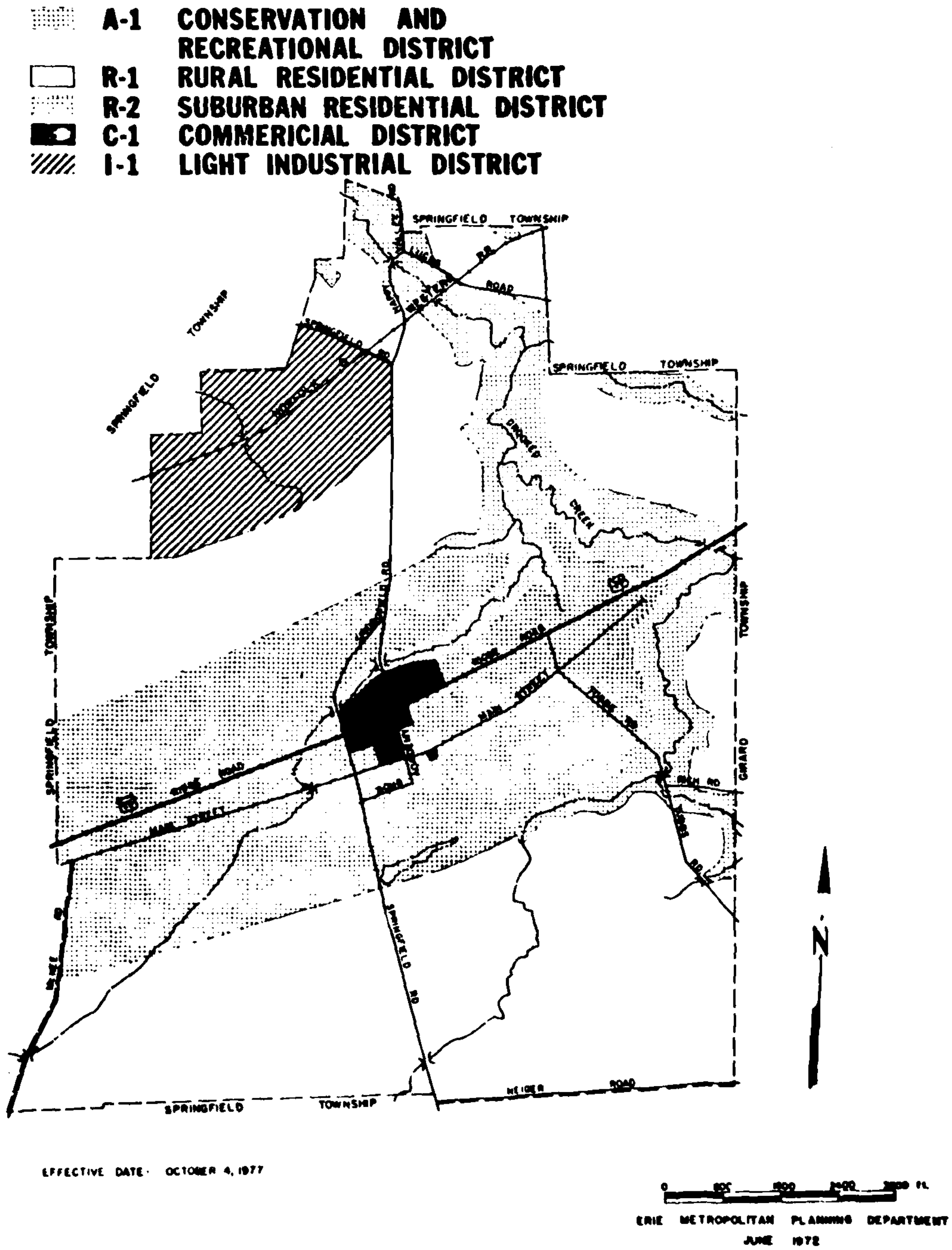
September 1977, and was establishing subdivision regulations at about the same time. Under these regulations, the township was divided into districts as shown in Figure 2-56 and Table 2-298. The data in Table 2-298 were computed from the preliminary draft of this ordinance. The approved map shows: a slight increase in I-1 area; division of the A-1 district into A-1 and A-3; less coastal zone area under the new A-1 or A-3 designations; and streams in A-1. Residential uses for the new districts defined under this ordinance are listed in Table 2-299. All uses permitted in the two industrial zones would be prohibited in the "A-1" zone although accessory industrial uses (not defined) are allowed as conditional "A-1" uses.

2.485
The northwest portion of the applicant's property in Springfield Township has been zoned Heavy Industrial in this 1977 ordinance. The U.S. Steel Corporation has requested that its entire property be zoned for heavy industry in order to provide the flexibility for laying out the proposed plant facilities and to avoid the need for future zoning changes. (2-102) However, the southern extent of the property remained Light Industrial in the September 1977 ordinance, while the northeastern section was zoned Conservation and Recreation and Rural Residential. All streams in the township, including those on the applicant's property, have an A-1 (Conservation-Recreation) district bordering them. The A-1 district (Conservation and Recreation) borders Lake Erie, and Raccoon Creek, Crooked Creek and Conneaut Creek, including their flood plains. These latter areas may be subject to additional restrictions. Although some residential use of this zone would be permitted, major proposed uses include agriculture and recreation. The same agricultural, conservation, and recreational uses would also be permitted in the other residential districts. Special projects or planned developments that depart from the regulations may be permitted on a minimum of two acres of land provided that average density of the development not exceed district density requirements. In such cases, it is proposed that a minimum of one acre per twenty dwelling units be improved for recreational use, with at least one such area being one-half acre in size. The industrial zones would be reserved for a wide range of storage, Light Industrial and Heavy Industrial uses. Mineral extraction and sanitary landfills would be conditional uses in both industrial zones, while junk yards, motor vehicle wreck yards, and animal slaughtering/curing are proposed conditional uses in the Heavy Industrial District. Uses not listed are also conditional uses in that district. Performance Standards for fire protection, electrical disturbances, noise, smoke, odors, air pollution, glare, erosion, and water pollution are required and the Zoning Hearing Board may utilize, at the applicant's expense, qualified experts to testify as to whether or not proposed plans conform to these standards. (2-103)



Source: Official Zoning Ordinance for Springfield Township, Board of Supervisors & Planning Commission, Springfield Township Erie County, Pennsylvania, September 1977.

FIGURE 2–56a ZONING MAP OF SPRINGFIELD TOWNSHIP



Source: Official Zoning Ordinance for East Springfield Borough, Board of Supervisors & Planning Commission, East Springfield Borough, Erie County Pennsylvania, October 1977.

FIGURE 2–66b ZONING MAP OF EAST SPRINGFIELD BOROUGH

Table 2-298

Springfield Township Zoning Districts

Zones	Approximate % of Township Land Area
Conservation and Recreation (A-1)	13%
Recreation (A-3)	
Rural Residential (R-1)	50
Suburban Residential (R-2)	22
Commercial (C-1)	2
Light Industrial (I-1)	6
Heavy Industrial (I-2)	7

Source: Zoning Ordinance for Springfield Township, 1977.

Table 2-299

Residential Use Requirements in Springfield Township

Zone	Minimum Lot Size	Partial List of Permitted Residential Uses	Notes
A-1	15,000 sq ft to 1 acre (depending upon sewer and water facility avail.)	Agriculture Single-family detached-seasonal dwellings	Individual mobile homes as a conditional use. Single-family detached dwellings; as conditional use.
A-3	5000 sq ft	Agriculture Single-family detached-seasonal dwellings	Individual mobile homes as a conditional use. Single-family detached dwellings; as conditional use.
R-1	15,000 sq ft to 1 acre (depending upon sewer and water facility avail.)	Agriculture Single-family detached-dwellings	Individual mobile homes and mobile homes parks as conditional use.
R-2	15,000 sq ft to 1 acre (depending upon sewer and water facility avail.)	Agriculture Single-family detached dwellings Multi-family dwellings	Individual mobile homes and mobile homes parks as conditional use.
C-1		Agriculture	Residential uses in combination with commercial use as a conditional use.
I-1		Agriculture	Temporary housing and sanitary landfills as conditional use.
I-2		Agriculture	Temporary housing as conditional use.

Source: The Springfield Township 1977 Zoning Ordinance.

2.486
The preliminary draft of the subdivision ordinance for Springfield Township requires that subdividers provide public water and sanitary sewage systems for developments of 50 lots or more and 25 lots or more, respectively. If public water and sewage systems are available within 1,000 feet of the subdivision, connection with these systems must be provided for subdivisions for any size. Similarly, in areas where a public sewer system is planned, the subdivision must provide capped sanitary sewers for subsequent connection with the planned system. Paved streets are required for new subdivisions, including mobile home parks. These latter developments must be on a minimum of five acres of land with minimum lot sizes of 6,000 square feet. A minimum of 10 percent of the park site must be devoted to recreational facilities. This same amount of open space for parks and playgrounds may also be required for other types of subdivision. (2-104) The preliminary draft of the East Springfield Borough 1977 Zoning Ordinance (2-105), which is expected to be adopted with modifications during the summer 1977, divides the Borough into five districts as shown in Table 2-300. The relative locations of these zones are presented in Figure 2-58. All proposed districts make some provision for residential uses as defined in Table 2-301. The proposed industrial district would be zoned for light industrial uses and these would be subject to performance standards. Development in flood plains is expected to be subject to restriction in the new zoning ordinance. Special projects or planned developments on a minimum of two acres of land would be permitted as a conditional use. Clustering of dwellings may not increase average density beyond that of the district and one acre per 20 dwelling units would have to be improved for recreational use, one area being at least one-half acre. (2-105) A preliminary subdivision ordinance for East Springfield Borough (2-106) is on a similar review schedule in September 1977. This ordinance would require that a subdivider provide paved streets and, when existing public systems are not available, public water and sanitary sewage collection and treatment facilities for subdivisions of 50 and 25 or more lots, respectively. Area for parks up to 10 percent of a proposed subdivision (or a fixed fee in lieu of such property) may be required. Mobile home parks must be at least two acres in size with minimum lot areas of 6,000 square feet. Streets for these parks would have to be paved and a minimum of eight percent of the total site devoted to recreational facilities.

Future Land Use in the Region, Independent of the Proposed Project

a) Land Requirements

2.487
Several of the available reports, including those prepared pursuant to programs administered by State planning agencies, project land use

Table 2-300

Proposed East Springfield Borough Zoning Districts

Zones		Approximate % of Borough Land Area
A-1	Conservation/Recreation	15%
R-1	Rural Residential	51
R-2	Suburban Residential	24
C-1	Commercial	4
I-1	Light Industrial	6

Source: East Springfield Borough 1977 Zoning Ordinance, Preliminary Draft.

Table 2-301

Proposed Residential Use Requirements in East Springfield Borough

Zone	Min. Lot Size (Sq Ft)	Partial List of Permitted Residential Uses	Notes
A-1 (Conservation-Recreaction)	10,000-20,000 (depending upon public water and sewage facility availability)	Agriculture Single-family detached dwellings. Single-family detached seasonal dwellings	Individual mobile homes a conditional use.
R-1 (Rural Residential)	15,000-1 acre (depending upon water and sewage facility availability	Agriculture Single-family detached dwellings	Individual mobile homes a conditional use. Mobile home parks a conditional use.
R-2 (Suburban Residential)	10,000-20,000 (depending upon water and sewage facility availability)	Agriculture Single-family detached dwellings. Multiple-family dwellings)	Individual mobile homes a conditional use. Mobile home parks a conditional use.
C-1			Residential uses in combination with commercial a conditional use.
I-1		Agriculture	Temporary housing a conditional use.

Source: The East Springfield Borough 1977, Zoning Ordinance, Preliminary Draft.

in the Regional Study Area for the year 2000. Since such projections are, by definition, highly speculative, and to maintain consistency in the data base used for analysis of environmental impact later in this statement, they were not used. Instead, the baseline population projections and land requirement factors developed for the SIMPACT IV Model were used. The one basic assumption in this approach is that the per capita land requirements of individuals and facilities within the baseline population would be the same as those for members of the "impact" population. There is no available demographic data to suggest that this assumption is erroneous. The results of the SIMPACT IV Model baseline analysis are shown in Table 2-302. In general, these projections reflect an expected continuation of the gradual increase in urbanization of the Region. The major differences between these projections and those in previously published reports is that these reflect the expectation of a considerable decrease in average per capita residential land requirements as land and homeowning costs continue to rise.

b) Potential Land Use Constraints

Physical Determinants

Overview

2.488
There are a variety of physical factors which, alone or in combination, can make land unsuitable or unattractive for development. The degree to which these factors can be considered in an analysis of this type is highly dependent on the extent to which the study area in question has been inventoried and evaluated. Unfortunately, there is considerable unevenness in the amount of available information on various potentially important physical factors in the Regional Study Area, especially in Ashtabula County. However, there is sufficient information to indicate that, with the exception of land with prime suitability for certain agricultural uses (i.e., dairy and fruit farming), there is an abundance of land in the Regional Study Area lacking physically constraining or unique natural features that would preclude further (sewered) development. The following discussion summarizes the available information on four major types of potential constraints: (1) soil and slope considerations (2) flood plain considerations, (3) unique natural features and (4) historic and archaeoligical resources. The emphasis is on the distribution of potentially growth-limited areas in the Coastal Communities.

Soils and Slope Considerations

2.489
Prime Agricultural Lands. The relative potential productivity of agricultural uses in Erie and Crawford Counties has been evaluated on

Table 2-302

Projected Baseline Land Use of the Coastal Communities and Regional Study Area -- 1979 and 1990(1)

	Total Acres	Residential 1979	Residential 1990	Commercial 1979	Commercial 1990	Industrial 1979	Industrial 1990	Institutional 1979	Institutional 1990	Recreational 1979	Recreational 1990	Vacant and Agricultural 1979	Vacant and Agricultural 1990	Transportation 1979	Transportation 1990
Pennsylvania Coastal Communities (Total)	83,700	8,850	9,600	1,300	1,500	650	900	2,050	2,350	950	1,300	66,350	66,450	5,650	5,900
Springfield Township & Borough(2)	23,000	1,000	1,050	50	50	50	50	650	500	50	50	21,100	20,950	1,150	1,700
Girard Area(3)	26,050	2,300	2,600	350	650	150	150	600	500	500	550	20,650	20,200	1,300	1,350
Fairview Township	18,350	2,000	2,300	150	200	50	100	600	900	150	250	16,650	15,950	1,100	1,150
Millcreek Township	18,700	4,650	4,000	700	800	200	250	750	850	250	450	10,200	9,600	2,100	2,150
Regional Study Area	1,191,250	51,350	53,400	5,000	5,400	3,450	3,700	10,850	11,700	71,400	71,750	1,027,150	1,022,000	N/A	N/A
Erie County	511,300	29,550	31,150	3,300	3,550	1,750	1,900	5,250	5,650	14,000	14,950	474,850	471,700	22,050	22,650
Crawford County	679,950	21,800	22,300	1,700	1,850	1,700	1,850	5,650	6,050	56,800	56,850	552,300	551,100	N/A	N/A
Ohio Coastal Communities (Total)	66,750	6,400	6,650	1,000	1,100	3,050	3,200	2,550	3,100	1,600	1,550	47,150	45,700	[illegible]	[illegible]
Conneaut City	17,550	1,800	1,650	100	100	800	850	300	300	150	200	13,450	13,300	1,150	1,200
Kingsville Township	13,000	850	950	250	300	50	100	1,200	1,400	150	200	10,500	10,050	850	900
Ashtabula Township	8,500	1,250	1,300	100	100	1,050	1,150	550	600	*	50	5,300	5,100	200	200
Ashtabula City	4,750	1,200	1,100	150	150	800	700	300	250	150	150	1,650	1,800	550	500
Saybrook Township	20,100	1,500	1,650	400	450	350	400	200	500	900	850	16,250	15,500	550	550
Regional Study Area															
Ashtabula County	442,050	14,900	15,300	1,950	2,100	3,400	3,600	9,200	9,750	9,400	9,550	401,200	401,500	N/A	N/A

N/A = Not Available.

*Less than 25.

(1) Based on 1973 acres except as noted.

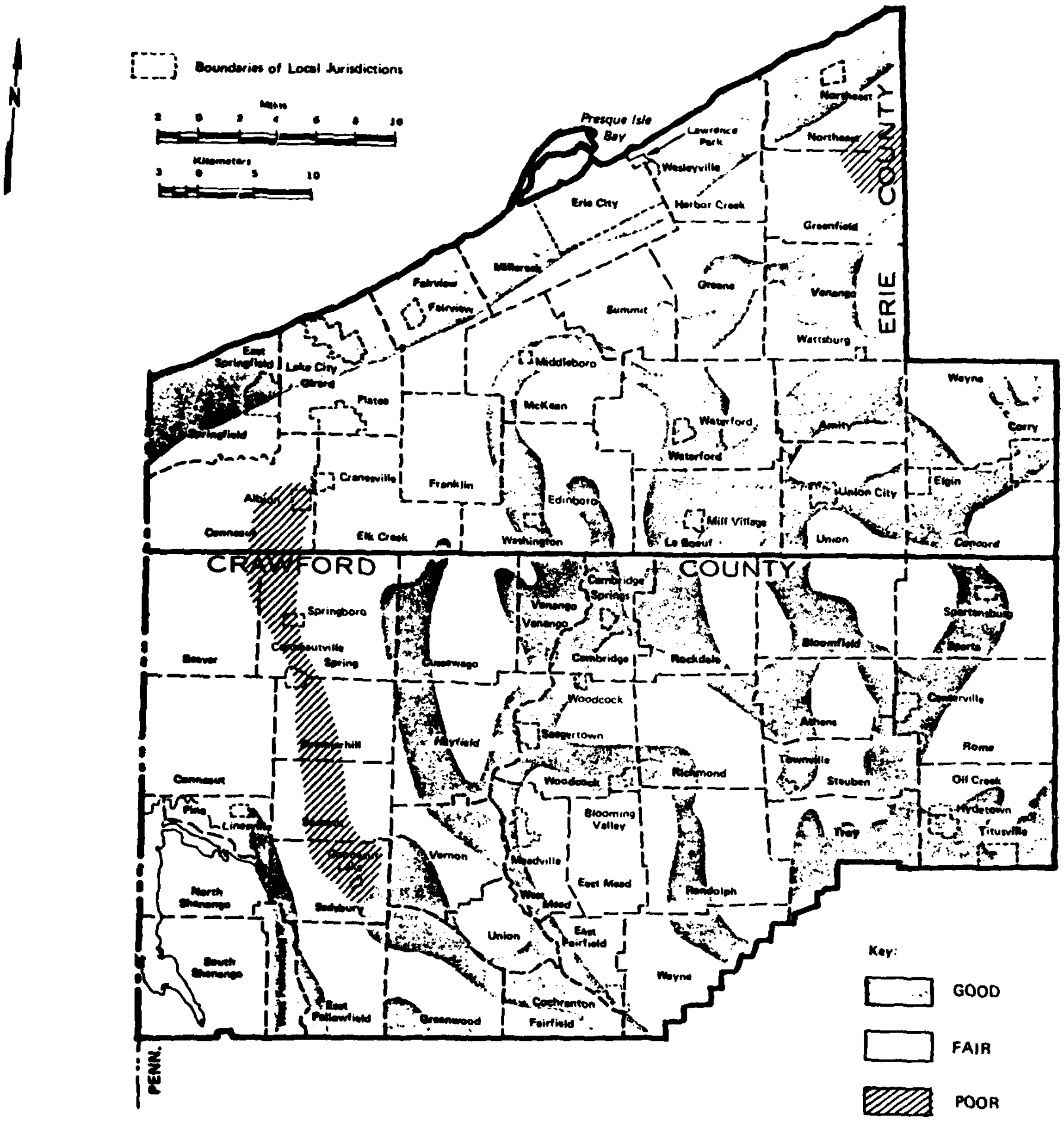
(2) Springfield Area includes Springfield Township and East Springfield Borough.

(3) Girard Area includes Girard Township, Girard Borough, Lake City, and Platea.

Source: Arthur D. Little, Inc. estimates, based on SIMPACT IV Model.

the basis of soil and climatic suitability. The results of the analysis are shown in Figure 2-57. The results of a similar rating procedure for Ashtabula County are shown in Figure 2-58. For Erie and Crawford Counties, agricultural capability is viewed under three broad categories: good, fair, and poor. The rating represents soil expectations, viewed as a whole, to produce crop yields under normal management practices. Soil capability in turn is dependent on drainage, topography, and parent materials. The first soil type with good agricultural capability is Connotton/Birdsall series found along the Lake Erie coastal plain. The soils are excellent soils for ameliorating climatic effects of Lake Erie, this enables Erie County to maintain its reputation for unique fruit production capability in the State. The second most productive soil type is the Chenango/Braceville soils, found particularly in Crawford County and along many of the valleys and flood plains in both counties. These soils are deep and well-drained. Overall, the most productive cropland, vineyard, and orchard soils are found along the central and western area of the Lake Erie coastal plain in the Regional Study Area. In addition, this same lake plain region affords some of the most poorly drained soils, soils which are unsuitable for onsite sewage disposal or subterraneous foundations for building construction. (2-107) The northern one-half to two-thirds of each of the Pennsylvania Coastal Communities is rated as "good" potential agricultural land by the State.

2.490
Soil Suitability for On-Lot Sewage Disposal. Good permeability to air and water for both surface soils and subsoils, and slopes not in excess of that adaptable for residential development are prime criteria for onsite disposal of sewage. Much of Erie and Ashtabula Counties consists of clay-like, sandy glacial tills which are relatively impermeable and, when combined with the high ground water table, are not suitable for subsurface disposal of sewage. Except for parts of the lake plain region, the majority of Ashtabula County is unsuited for ground elimination of sewage, (see Figure 2-59). Two relatively small isolated regions in the southeastern corner of the county are adaptable to onsite septic elimination, with the remainder of the county being unsuitable because of high water tables and low permeability. The lake plain in Ashtabula County extends into western Erie County, affording the same types of limitations on ground sewage elimination (see Figure 2-60). The southeastern portion of Erie County is basically rural and less densely populated than other parts of the county. This area affords some opportunities for ground sewage elimination, while the remainder of the county is largely unsuited for this use. In the Coastal Communities, soils potentially suitable for on-lot disposal are confined to a narrow band that bisects the area, being widest in Kingsville, northern Conneaut, and East Springfield, and narrowest in Fairview and

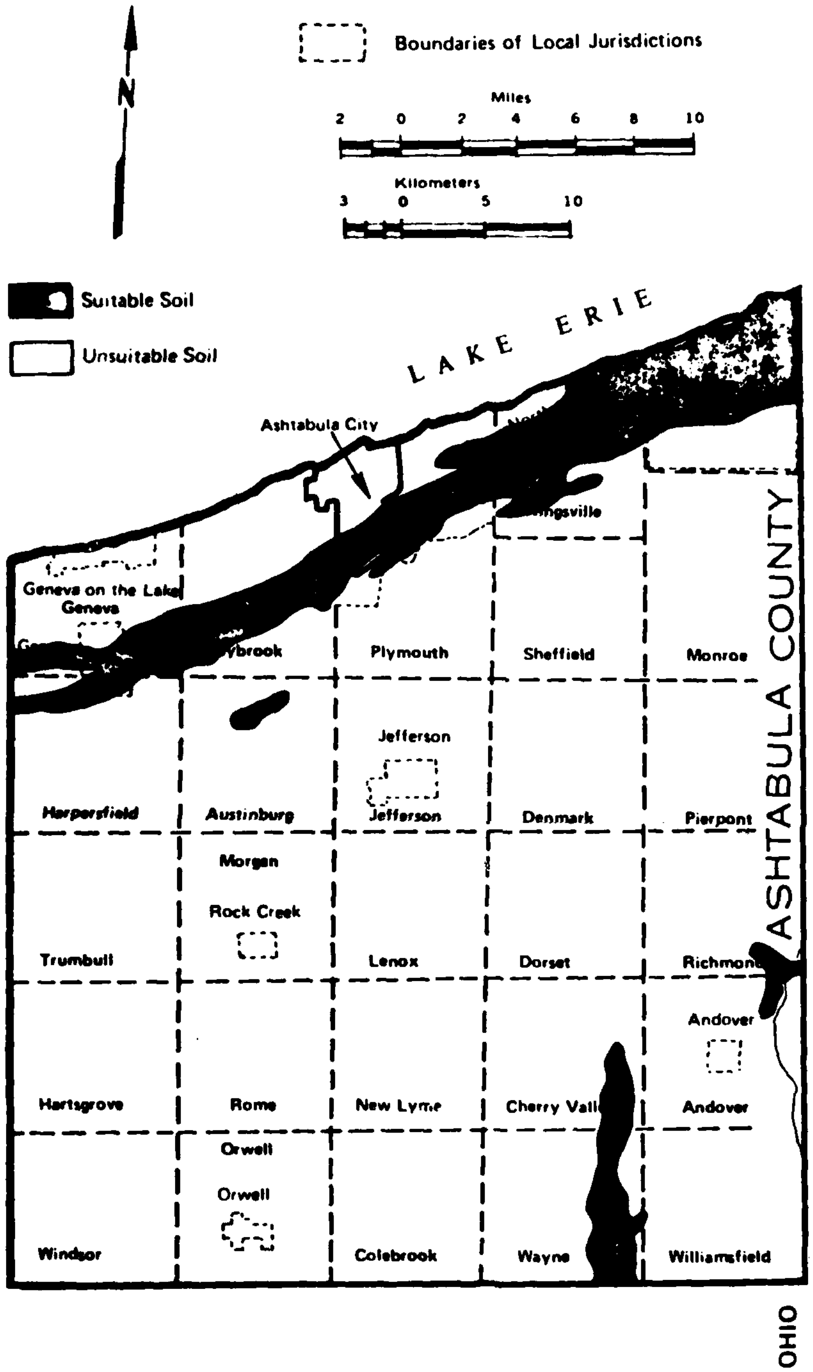


Original Source: General Soil Map of Pennsylvania, August 1972 U.S. Soil Conservation Service.
As Located In: Northwest Area Profile, A Baseline for the Future Commonwealth of Pennsylvania.

FIGURE 2–57 **SUITABILITY OF LAND FOR AGRICULTURAL USE IN ERIE AND CRAWFORD COUNTIES**

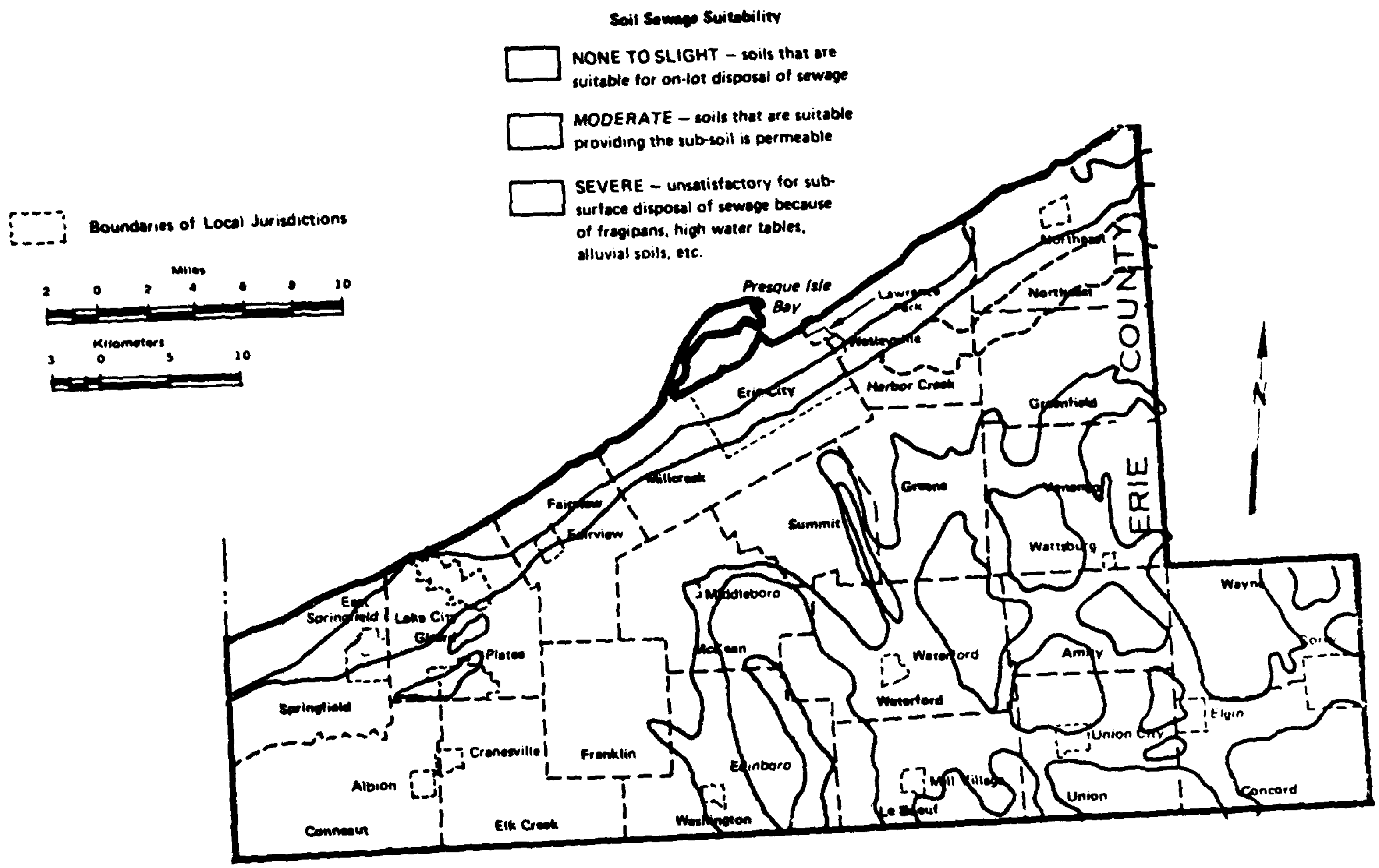
Source: Land Use-Ashtabula County Study of Present & Future and Recommendations Ashtabula County Planning Commission County Office Building Jefferson, Ohio 1972.

FIGURE 2–58 SOIL TYPE MAP OF ASHTABULA COUNTY



Source: Land Use-Ashtabula County Study of Present & Future and Recommendations
Ashtabula County Planning Commission County Office Building Jefferson, Ohio, 1972.

FIGURE 2–59 SUITABILITY OF SOILS FOR ON-LOT SEWAGE DISPOSAL IN ASHTABULA COUNTY



Source: Erie County Land Use Plan, Erie County Metropolitan Planning Department, 1971.

FIGURE 2–60 SUITABILITY OF SOILS FOR ON-LOT SEWAGE DISPOSAL IN ERIE COUNTY

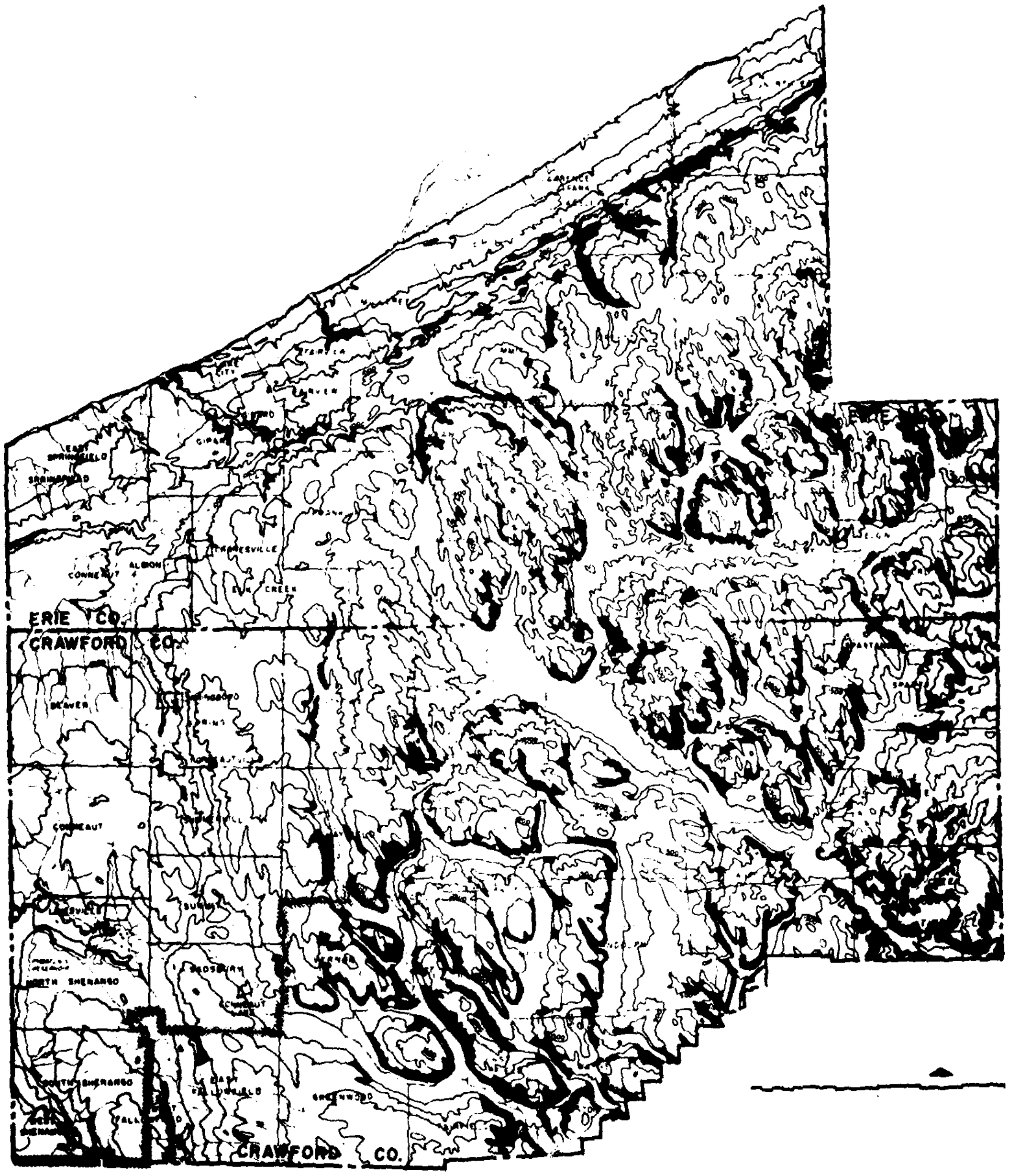
Millcreek. The more rural of the communities lack interceptor sewers, and northwestern Erie County lacks modern treatment facilities. Thus, lack of sewage treatment capabilities may significantly restrict growth in the Coastal Communities.

2.491
Steep Slopes. Areas with slopes greater than 15° are generally regarded as too steep to support typical residential developments. Such areas have been delineated for the Pennsylvania Regional Study Area and are shown in Figure 2-61. In the Pennsylvania Coastal Communities, the areas of steep slope are minor and are confined to the escarpments bordering portions of the Elk and Walnut creek ravines in Girard, Fairview, and Millcreek.

Flood Plain Considerations

2.492
Ashtabula County. Ashtabula County is preparing preliminary maps showing floodprone areas. Like Erie, the county is transversed by a multitude of streams and rivers and, therefore, is very prone to localized high water levels. The 100-year flood level is a criterion in establishing floodprone regions of the county. Specifically, a delineated region is one which would become submerged from rising high water and not back up of storm water and/or sewer waters. In October of 1976 emergency blanket insurance, in the amount of 25-35 per $100 evaluation and $10,000 in contents insurance, was granted to all townships and other unincorporated areas in Ohio. Continued participation in this Federal program is contingent on implementation of flood-protection oriented land use planning.

2.493
Erie and Crawford Counties. The Erie-Crawford region contributes to three different major drainage systems, the Lake Erie Basin, the Allegheny River Basin, and the Beaver River Basin. Most of the large drainage courses, with the exception of Conneaut and Elk Creeks, are short in length with steep gradients, resulting in few extensive flood plains. Storm flows and melt waters discharge directly and quickly into Lake Erie. However, Conneaut, Elk, Crooked, and Walnut Creeks, on the other hand, take a more circuitous and flat route before reaching Lake Erie; and their flood plains contain the bulk of floodprone areas in the Pennsylvania Coastal Communities. The U.S. Department of Housing and Urban Development (HUD) is in the process of evaluating the 100-year floodprone regions of both Erie and Ashtabula Counties. Erie County is in a more advanced stage of [illegible] than Ashtabula. The greatest incidence of flood prone [illegible] the southeast part of Erie County, particularly in the [illegible]rry. Those selected areas mapped thus far by the USGS [illegible] Figure 2-62. Flooding occurs in a few areas of the

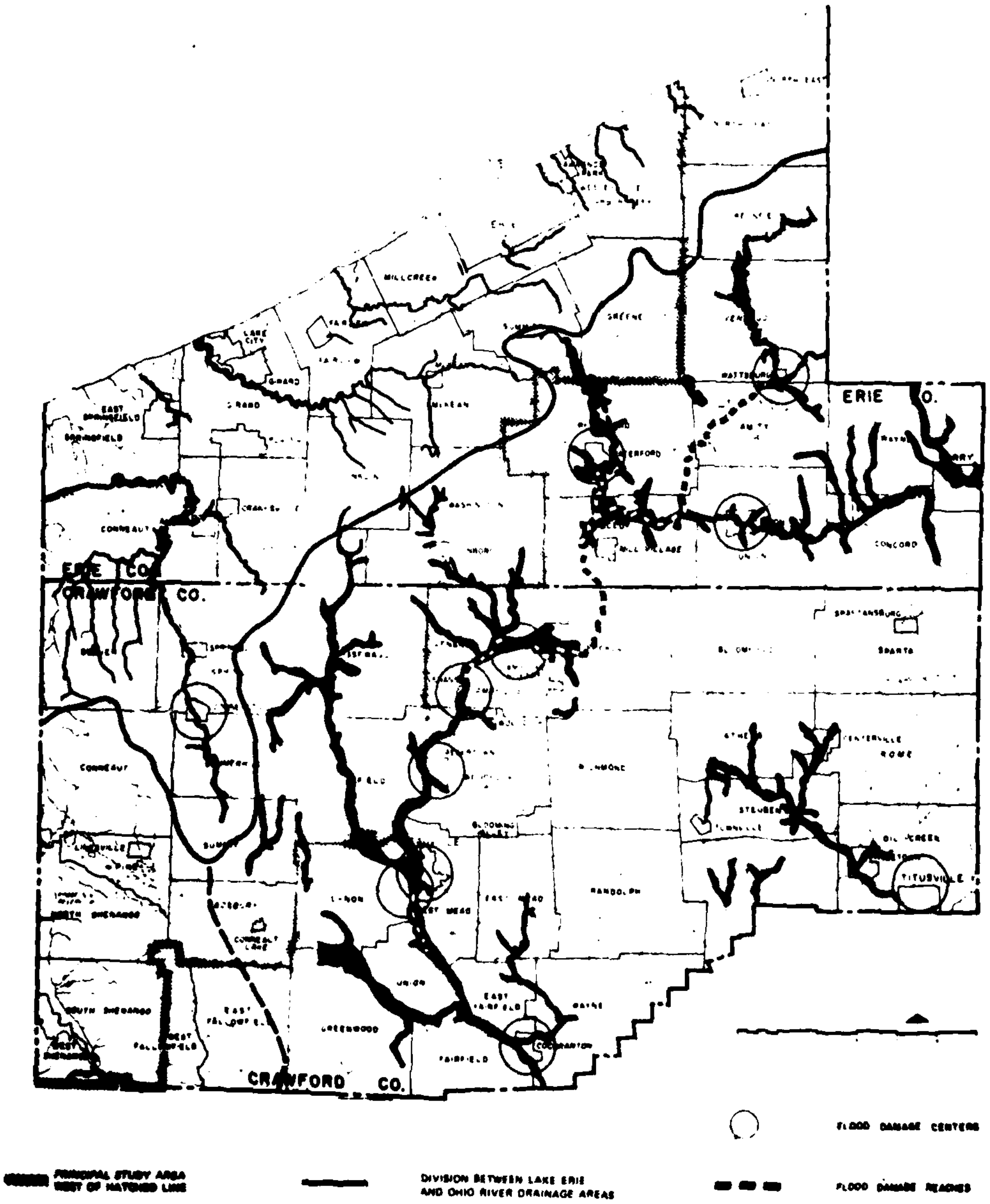


PRINCIPAL STUDY AREA WEST OF HATCHED LINE

Areas With 15% or Greater Slope.

Original Source: Office of State Planning & Development, Based on U.S. Geological Survey Quadrangle Maps.
As Located In: Northwest Area Profile, A Baseline for the Future Commonwealth of Pennsylvania.

FIGURE 2–61 STEEP SLOPE AREAS IN ERIE AND CRAWFORD COUNTIES



Original Source: U.S. Geological Survey Maps of Flood Prone Areas, 1973.
Pennsylvania Department of Environmental Resources, Bureau of Resources Programming.
As Located In: Northwest Area Profile, A Baseline for the Future, Commonwealth of Pennsylvania, 1977.

FIGURE 2–62 PARTIAL DELINEATION OF FLOOD PROBLEM AREAS IN ERIE AND CRAWFORD COUNTIES

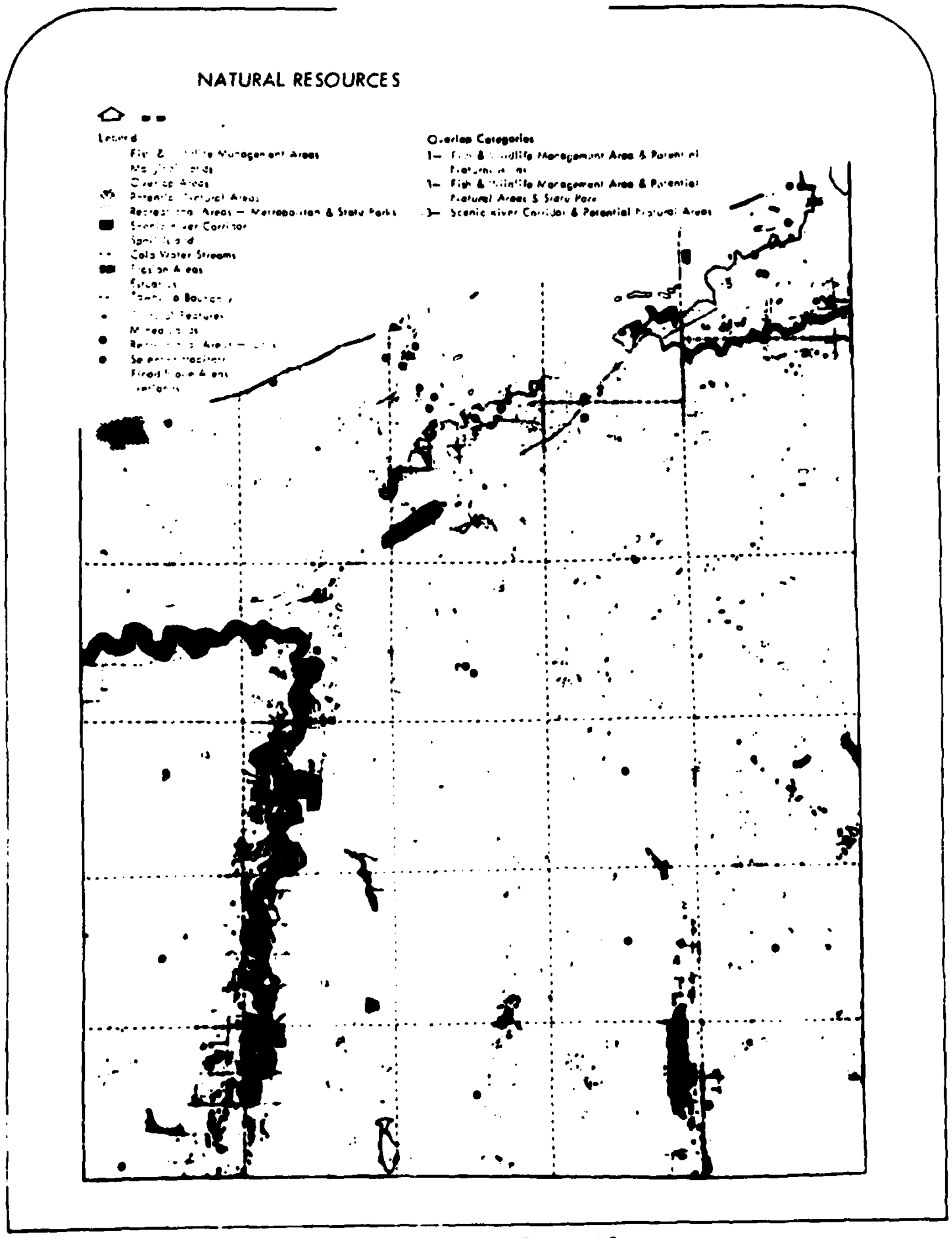
county and has been a significant limiting factor along French Creek, particularly around Mill Village and Waterford. Along the lake drainage area there is relatively little flooding because of length of streams from origin to destination. As a whole, with the exception of Platea Borough, the whole county is considered to require Federal insurance.

Unique Natural Features

2.494
This category of physical factors includes living and non-living resources whose presence is not a major physical deterrent to development but whose preservation may be highly valued by the general public or one or more major interest groups. These types of features include special wildlife habitats, such as wetlands and remnant climax forests, and special geological formations such as glacial works and exposed fossil sites. In addition, flowing waters with unusual aesthetic and/or habitat values can also be considered in this category of resource, especially when designated or under evaluation for status as a "Wild and Scenic" stream. As in other categories, the availability and format of presentation of inventories of unique natural features in the Regional Study Area is uneven. The available information on Ashtabula County is presented in map form in Figure 2-63. Similar data for Erie and Crawford Counties is presented in Figures 2-64 and 2-65, respectively. Supporting data on the nature of the areas shown is available in more detail for Pennsylvania than for Ohio.

2.495
In the Ohio Coastal Communities, the most abundant type of designated unique natural feature is the small wetland, which is found in each of the communities. The greatest concentration is found in northeastern Kingsville Township, with the largest number of individual parcels in north-central Saybrook Township. Portions of the Conneaut Creek watershed in Kingsville and Conneaut have been mentioned as potential Natural Areas and/or Scenic River Corridors subject to designation by the Ohio Department of Natural Resources (ODNR). The Ohio portion of Turkey Creek is one of only two Lake Erie tributaries in the State currently managed by the ODNR as coldwater fisheries recruitment habitat for the subsequent creation of salmonid beach fisheries on the beaches bordering the nearby Lake Erie.

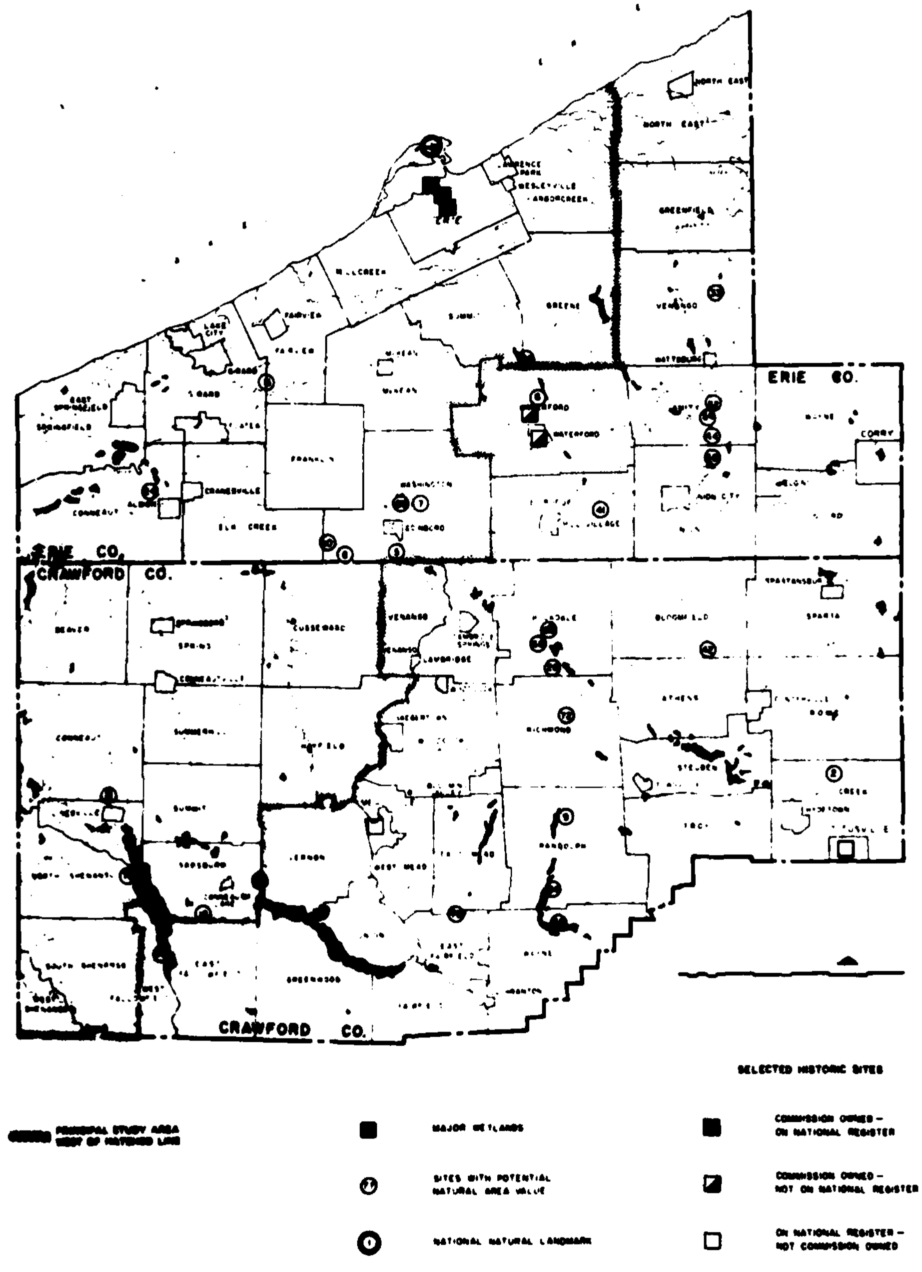
2.496
In the Pennsylvania Coastal Communities, either potential Scenic Rivers, watersheds with Conservation Area Streams, or wetlands, are found in each of the communities. The Springfield area has the majority of the wetlands (both in area and number) in the Coastal



Original Source: Ohio Department of Natural Resources, U.S. Geological Survey

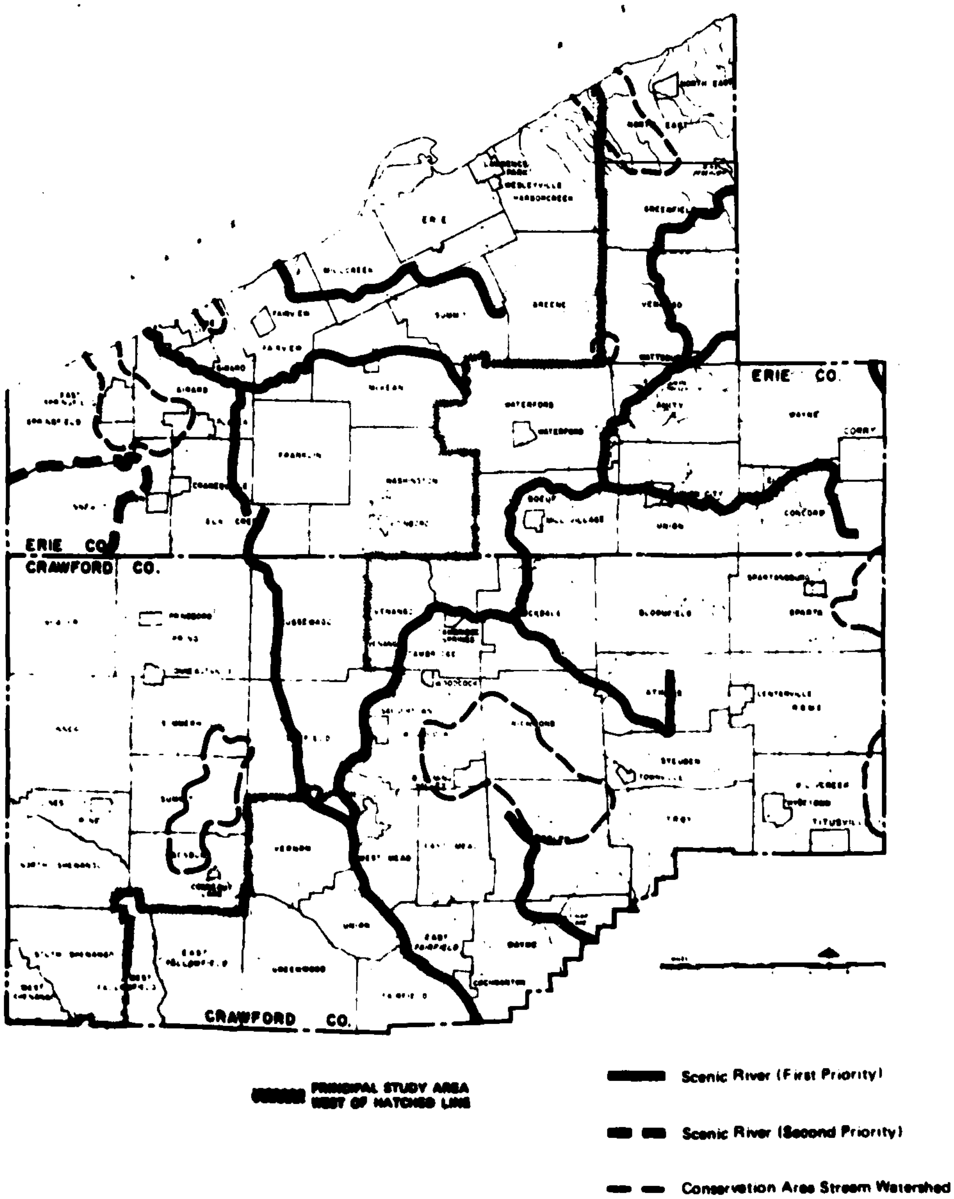
As Located In: Baseline Study of Ashtabula County, Ohio.
A Basic Planning Document of Socio-Economic Characteristics, Volume 2.
The Regional Development Office of Ashtabula County at Conneaut, Ohio. The State of Ohio Department of Economic and Community Development, August, 1977.

FIGURE 2–63 NATURAL RESOURCES IN ASHTABULA COUNTY



Original Source: U.S. Geological Survey Quadrangle Maps.
Preliminary List of Natural Areas in Pennsylvania by the Western Pennsylvania Conservancy (1974).
Pennsylvania's Recreation Plan, 1976, Office of State Planning and Development.
As Located In: Northwest Area Profile, A Baseline for the Future Commonwealth of Pennsylvania, 1977.

FIGURE 2–64 ENVIRONMENTALLY SENSITIVE AREAS IN ERIE & CRAWFORD COUNTIES



Original Source: Pennsylvania Scenic Rivers Inventory, December 1975, Department of Environmental Resources; And Bureau of Wate Quality Management, Department of Environmental Resources.

As Located In: Northwest Area Profile, A Baseline for the Future Commonwealth of Pennsylvania, 1977.

FIGURE 2–65 POTENTIAL SCENIC RIVERS AND WATERSHEDS WITH DESIGNATED CONSERVATION AREA STREAMS IN ERIE & CRAWFORD COUNTIES

Communities. These are located mainly in the southeastern section of the community around the headwaters of Raccoon and Crooked Creeks. The Crooked Creek watershed, about half of which lies in Springfield, contains a designated Conservation Area Stream. The stretch of Conneaut Creek which forms the southern boundary of Springfield Township is about half of the mileage of that stream under consideration for legislative designation as a Scenic River because of its aesthetic qualities. The 20-acre Conneaut Creek heron rookery is about two miles southeast of the area. Jumbo Woods, a State Game Land reportedly containing mature climax forest, a blue heron rookery, and a diverse vegetation, is about four miles south of Springfield. (2-108) The Girard Area contains the remainder of the designated wetlands in the Coastal Communities. It also contains the lower reach of Elk Creek under consideration for scenic status as an aesthetic resource, and all of Godfrey Run, a Conservation Area Stream watershed. The 100-acre Devil's Backbone along Elk Creek on the Girard/Fairview border is a unique geologic feature with a reported stand of mature climax forest. (2-108) The Fairview Area contains the middle reach of Elk Creek including part of the Devil's Backbone. (2-108) It also contains the lower reach of Walnut Creek, under consideration for designation as a Scenic River for recreational purposes. There is evidence that some of the tributaries to Walnut Creek support naturally reproducing salmonid populations. The bulk of the remainder of Walnut Creek, including the lower reaches of each of its major tributaries, is the only designated unique natural feature in Millcreek Township.

Historic and Archeological Resources

Introduction

2.497
Cultural resource surveys of the proposed Lakefront plant site and the surrounding Regional Study Area were conducted during 1977 under the direction of Dr. David S. Brose of the Cleveland Museum of Natural History. As part of this effort, a review of the historical and archeological literature was conducted for the Regional Study Area. Environmental data for identified archeological sites were obtained and used to create a geographic moded for the purpose of predicting probable high frequency locations of prehistoric sites in unsurveyed areas. Such a model is not considered necessary for standing, directly observable historic sites. In addition, an archeological reconnaissance and subsurface investigation of the proposed lakefront plant site was conducted between May and June of 1977. The selected results of this survey are summarized below (2-109).

The Proposed Project Site

2.498
No historic sites on, or nominated to, the National Register of Historic Places were identified within the proposed project site as a result of the literature review. Furthermore, no historic sites potentially eligible for the National Register were identified on the proposed plant site. (2-109) Similarly, no archeological sites on, or nominated to, the National Register were located on the proposed plant site. Archeological sites within the three-county region identified as potentially eligible for nomination to the National Register are discussed below in this section under Regional Study Area. Numerous historic sites in the three-county region eligible for or included on the National Register were identified, descriptively listed and located on maps. Archeological sites on the proposed plant site judged by the investigators as eligible for nomination were identified (or verified) by field reconnaissance including subsurface investigation. The sampling protocol for this latter program was designed by utilizing environmental information from known prehistoric sites in the Regional Study Area to predict probable locations of potentially significant archeological remains (2-110). The field program resulted in the excavation of over 6,700 "culturally sterile" test pits, ranging in areas from 0.5 x 0.5 meters to 1.0 x 1.5 meters. More than 160 additional test pits yielded archeological materials from which some sixteen potentially significant prehistoric sites were identified. The significance of these 16 sites was further delineated by over 50 1.0 x 1.0, 1.0 x 0.5, and 1.5 x 1.0 meter excavations and machine-assisted stripping of overburden from six of the 16 sites.

2.499
The 16 prehistoric archeological sites located within the proposed plant area listed in Table 2-303 have been categorized by site identification numbers only. Local names for these numbered sites as well as mapped locations have been eliminated from this report in order to minimize potential pilfering of artifacts that could also be deemed more valuable for research purposes if located "in situ." In agreement with predictions, the environmentally-related sampling strategy resulted in detailed and strongly verified evidence that this portion of the Lake Erie regional drainage system supported little intensive prehistoric occupation, except along fossil or modern lake beach ridges and bluffs where they were cut by reasonably mature drainage systems. (2-110) Of the 16 prehistoric archeological sites located by subsurface sampling on the proposed lakefront site, six were considered by the investigators to be degraded and disturbed sites with little significant research potential. A seventh site was considered a functional segment of another site on property not controlled by U.S. Steel. Alone, that segment was not considered

Table 2-303

Identified Prehistoric Archaeological Sites on the Proposed Lakefront Plant Site

Site Identification Number	Site Type	Site Area (in meters)	Investigators Judgement of Significance
1	Archaic Campsite	50 x 20	Does not appear eligible for nomination to the National Register.
2	Archaic Campsite	10 x 20	Appears to be eligible for nomination to the National Register.
3	Archaic Campsite	10 x 20	
4	Archaic Campsite	10 x 20	
5	Early Woodland Campsite	25 x 20	Recommended not eligible for nomination to the National Register.
6	Archaic Campsite	50 x 70	Recommended that site be considered eligible for nomination to the National Register.
7	Archaic Campsite	20 x 50	Recommended ineligible for nomination to National Register.
8	Early Late Woodland Campsite	50 x 100	Recommended ineligible for nomination to National Register.
9	Late Woodland Campsites	100 x 100	Suggested eligible for nomination to National Register.
10	Late Iroquoian Campsite	100 x 150	

Table 2-303 (Continued)

Site Identification Number	Site Type	Site Area (in meters)	Investigators Judgement of Significance
11	Late Woodland Campsite	20 x 10	Strongly recommended eligible for nomination to National Register; immediate action to preserve sites was recommended.
12	Iroquoian Village	75 x 250	
13	Portion of Iroquoian Village	20 x 15	
14	Middle Woodland Campsite	50 x 30	Doubtful eligibility for nomination to National Register.
15	Late Woodland Campsite	5 x 25	Does not appear eligible for nomination to National Register.
16	Portion of Late Woodland Village	5 x 50	A portion of a larger site. Therefore, probably not eligible for nomination to National Register alone.

eligible for nomination to the National Register, although it does contain cultural remains and deposits considered significant.

2.500
Collectively, the sites identified by numbers 2, 3, and 4 represent a unified, prehistoric district. These sites have been documented to represent a Middle Archaic locus of population sub-aggregate reutilization of a specific ecological situation. These sites offer significant research potential to test hypotheses of developing Archaic stylistic regionalization and economic specialization and could be used to develop a chronology and regional stylistic and cultural-ecological model for the unknown area between the Middle Archaic cultures of the Ohio Valley and the lower Great Lakes. Investigators recommended that this site be nominated to the National Register (2-109). Site No. 6 appears at least partially intact and seems to offer some significant research potential to test specific hypotheses of ecological readjustment and economic adaptation from middle-to-late Archaic Times (2-109). This site was recommended for nomination to the National Register. Sites 9 and 10 have been strongly agreed to represent a unified prehistoric district along the ridges overlooking two small drainage systems. This district appears eligible for nomination to the National Register. Numerous significant research problems have been identified which may be answered by subsurface examination of these sites (2-109). The three remaining sites, as a group, represent functional segments of a single, highly significant, archeological site considered eligible for the National Register (2-109). Information gathered to date indicates that this site was the location of intensive prehistoric occupation. Unfortunately, it appears that major portions of the site were removed with construction activities prior to the investigations cited here. Furthermore, long-term preservation of this site would be difficult due to continued alterations of the physical surroundings, including bluff erosion, and removal of artifacts. By July 1977, unknown personnel had reportedly removed some quantity of aboriginal cultural materials from the site and destroyed much of the stratigraphic integrity of several exposed features. (2-109) For all of the above-mentioned reasons, this site was excavated for the recovery of artifacts during the summer of 1977.

The Regional Study Area

2.501
Following are excerpts from the Final Report on the Discriminant Archeological Analysis of Erie and Crawford Counties, Pennsylvania, Ashtabula County, Ohio (Secondary Study Area), prepared for U.S. Steel Corporation by David S. Brose, Bernard Warner, and Renata B. Wolynec. (2-110) The county maps referred to are presented in Figures 66, 67, and 68.

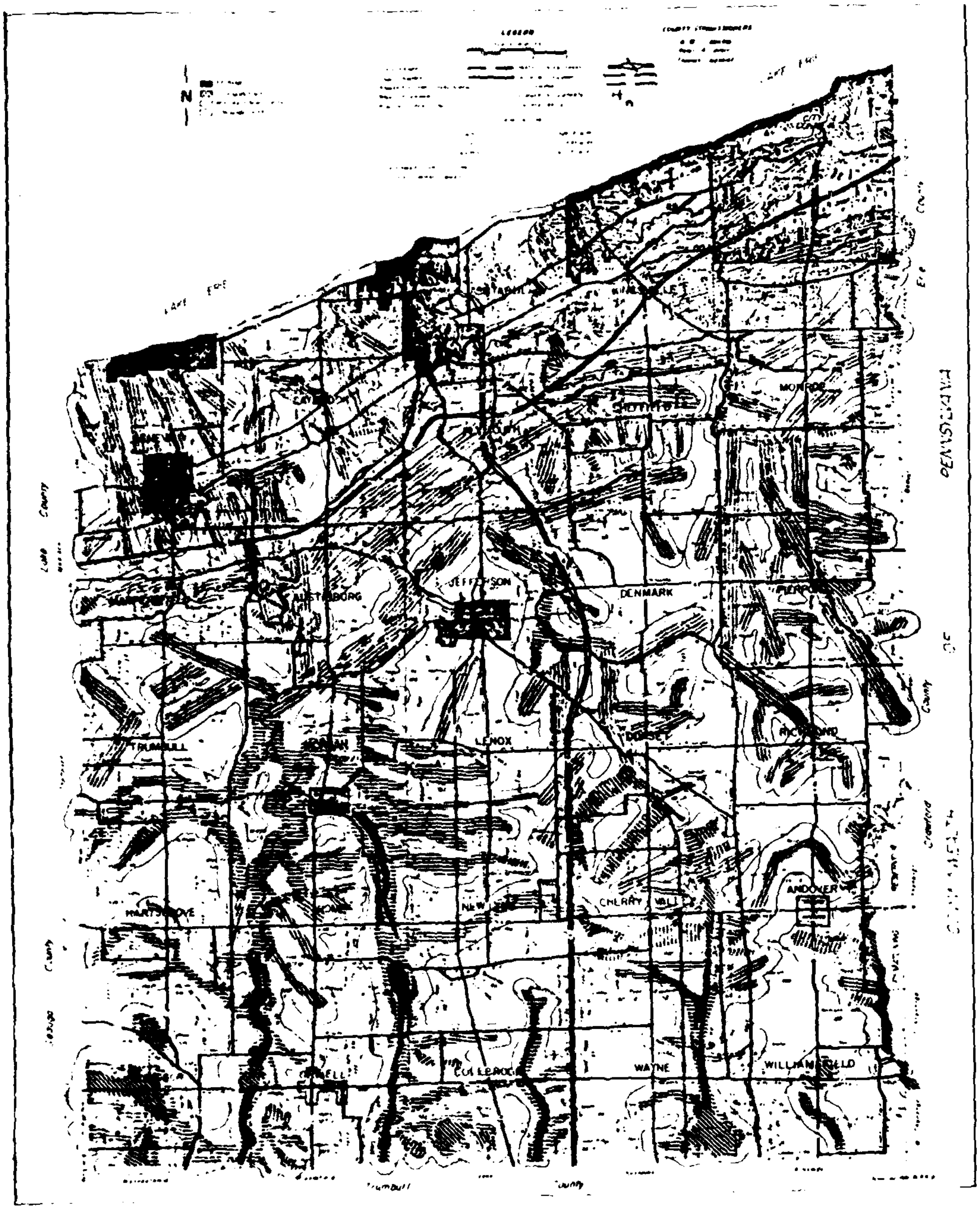


FIGURE 2–66 ARCHAEOLOGICAL MAPPING – ASHTABULA COUNTY

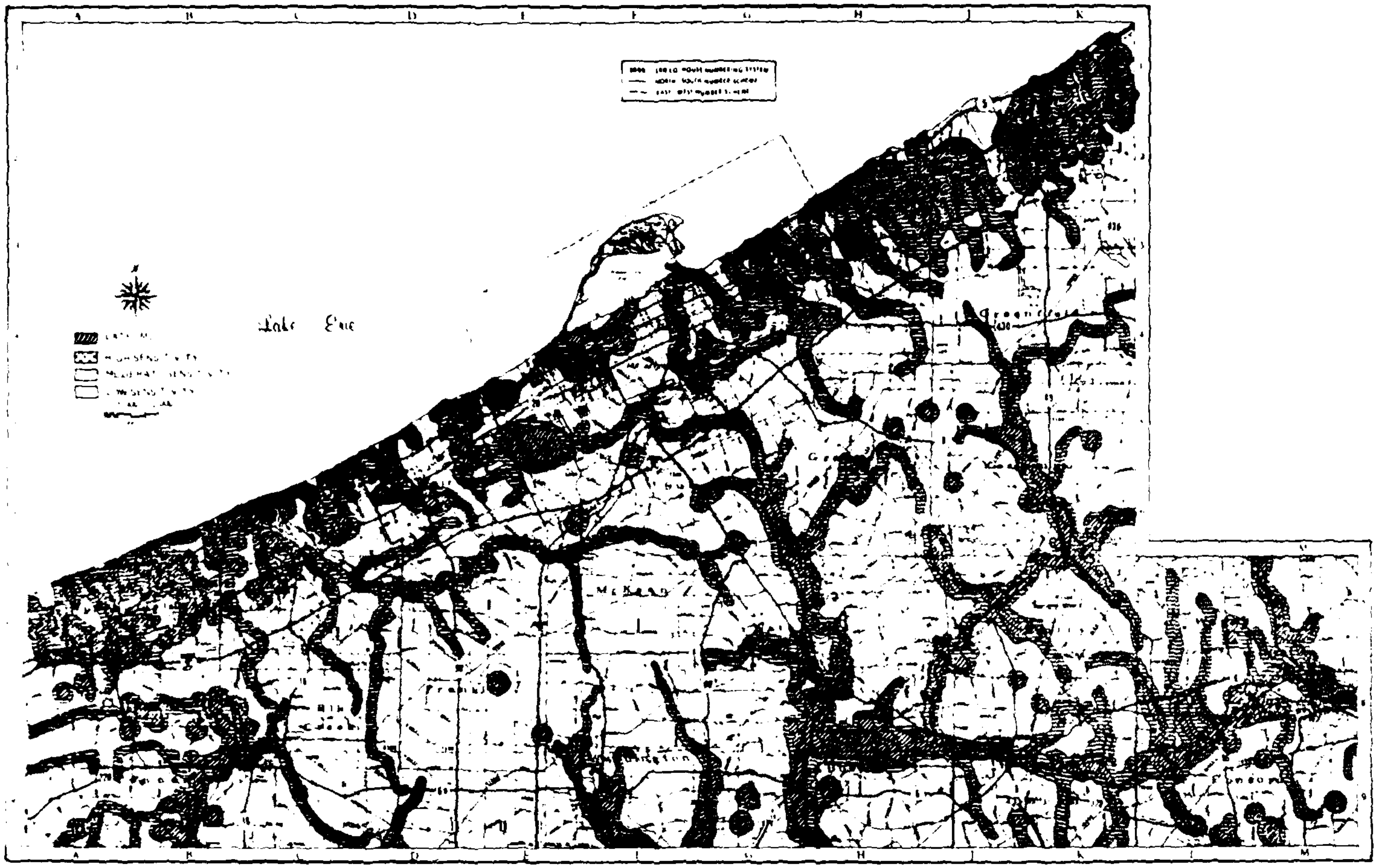


FIGURE 2–67 ARCHAEOLOGICAL MAPPING – ERIE COUNTY

AD-A079 397 CORPS OF ENGINEERS BUFFALO N Y BUFFALO DISTRICT F/G 5/5
FINAL ENVIRONMENTAL IMPACT STATEMENT. PERMIT APPLICATION BY UNI--ETC(U)
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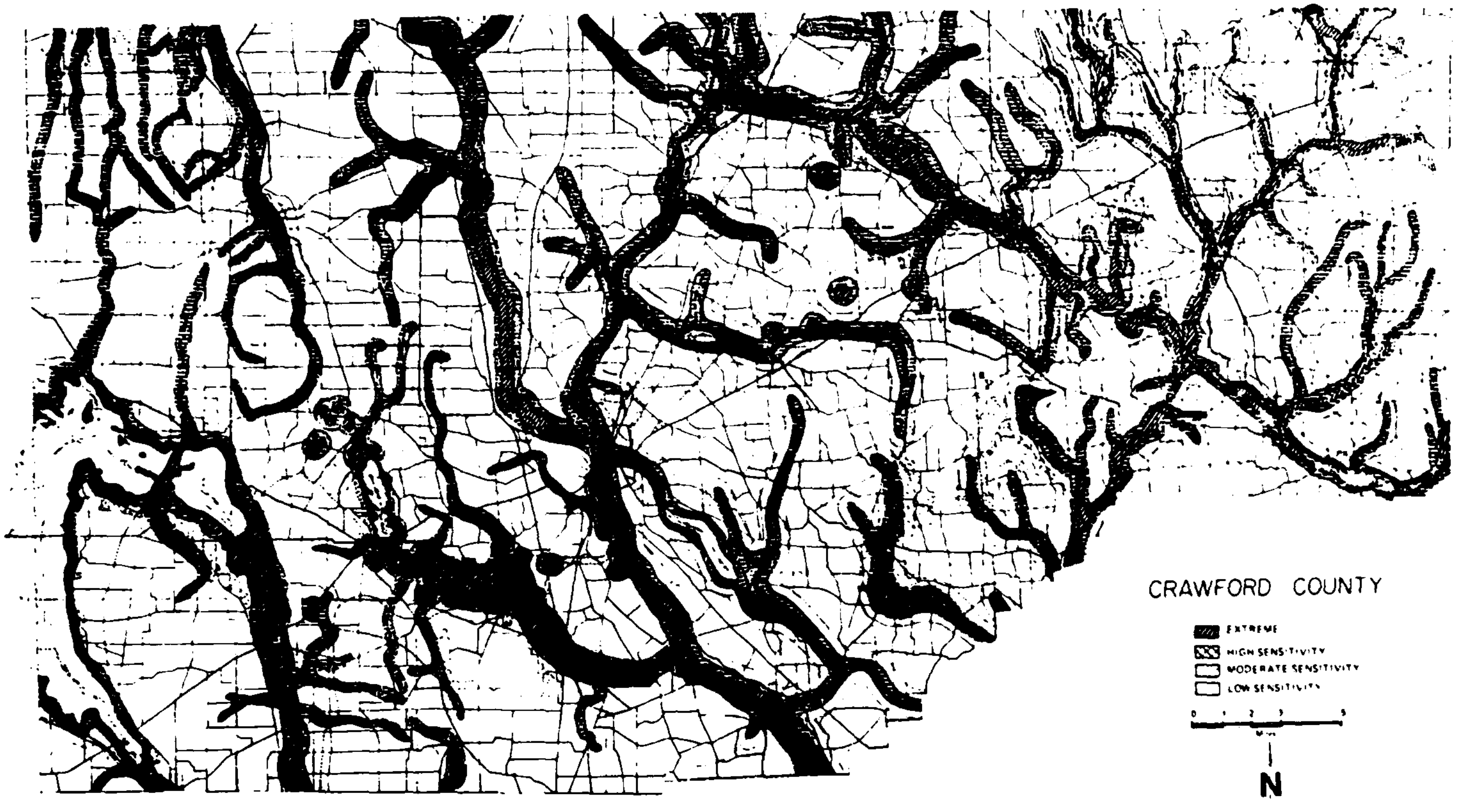


FIGURE 2–68 ARCHAEOLOGICAL MAPPING – CRAWFORD COUNTY

"The secondary area study performed has resulted in an up-to-date synthesis of all available historical and archeological information concerning Ashtabula County, Ohio, and Crawford and Erie Counties, Pennsylvania. A series of county maps have been prepared which located all known archeological sites and historic structures added to, nominated to, or deemed eligible for the National Register of Historic Places. In addition, the locations of all presently known archeological sites in the tri-county area have been entered on these maps. A series of appended lists for Ashtabula, Crawford, and Erie Counties detail the historical and archeological information available for each of the mapped county sites."

"It must be reiterated that while the documented historic sites accurately reflect the locations of all significant extant historic sites in the study area with an estimated confidence level exceeding 96 percent, the documented archeological sites are estimated to reflect the locations of less than 30 percent of existing archeological sites." (2-110) Thus, an extropolation "...from the observable proximal ecological variables of the 252 well-documented previously known archeological sites (was made) to discern the significant factors which can be used for retrodiction of archeological site locations." (2-109) Environmental parameters from test sites examined in subsurface investigations of the proposed lakefront plant site were also used in the analysis of the three-county Regional Study Area. This information was then used to prepare maps of the three-county region that graphically represent zones of variables "sensitivity" for use in predicting the location of prehistoric archeological sites.

This analysis" ...revealed that all of the recovered archeological samples occurred in areas of predicted extreme and high sensitivity. It might, however, be suggested that small seasonal prehistoric campsites of any period (probably 85 percent of all archeological sites in the area) can be better predicted by analyses of key ecological variables than can the large, possibly more significant, more permanent villages which may still appear randomly located with respect to most variables. It should be pointed out that other lower-order studies of this nature...suggest that a primary consideration for the location of such villages is ease of defense." (2-110)

It was concluded that "these (sensitivity) maps thus represent the best approximation of the differing probability of encountering the majority of prehistoric archeological sites in various areas of Ashtabula, Crawford, and Erie counties." (2-110)

Coordination

2.502
To obtain the input of the agencies responsible for the protection and recovery of archeological resources, the results of the onsite and secondary field surveys were forwarded to the Heritage, Conservation, and Recreation Services and the appropriate State Historic Preservation Officers. Evidence of cultural resource coordination is presented on pages A-1 through A-18.

Institutional Determinants

Federal Government

2.503
Federal air quality standards could be a major determinant for the type of development permitted to locate in or attracted to the Regional Study Area. The inclusive AQCR is experiencing problems with the attainment of hydrocarbon/oxidant and particulate standards. New developments that might otherwise choose to locate in the Regional Study Area may be required to meet emissions offset or Lowest Achievable Emission Requirements (LAER) standards more stringent than National New Source Performance Standards (NSPS) for these or other problem pollutants. Water quality considerations may also affect the location and/or rate of growth of future development. The poor septic suitability and low or "flashy" flow characteristic of many of the streams in the Coastal Communities may engender more expensive sewage treatment requirements for new developments. Discharge to Lake Erie may be an option where it is cost effective, and this may in turn concentrate development pressure in the coastal zone. With the allocation of Federal funds for additional public sewer systems and extension of existing ones, and the amount of space still "open" in the Regional Study Area, these limitations are not expected to be significant in light of baseline population projections.

State Government

2.504
Beyond the implementation of air and water pollution control regulations, State land use initiatives are expected to be few and limited to very specific areas. The Federal Coastal Zone Management Program requires some direct State involvement in the achievement of coastal zone use objectives. Use designations for coastal areas, public and private beach access, and protection of prime agricultural land are all possible categories of direct State involvement, based on coastal zone management and land use initiatives in other States. However, neither Ohio nor Pennsylvania is expected to develop and implement

major initiatives in these categories before 1990. Flood plain and wetlands protection regulations do not exist in either State but, like coastal zone management, are acknowledged concerns. The active preservation of agricultural lands is part of proposed Pennsylvania planning policy. (2-71) There are numerous pieces of legislation in Pennsylvania for acquiring land for conservation; some have been funded and others could be. (2-71) Both States have preferential tax assessments for agricultural uses and Pennsylvania planners have suggested extending this program to wetlands as an incentive to protect these resources. (2-70) However, none of these programs appears likely to have significant impact on the Principal Study Area before 1990. Scenic Rivers programs especially in Pennsylvania, may offer some protection for relatively untouched streams in the Regional Study Area. Pennsylvania's designation of "conservation stream" watersheds may provide deterrents to development in stream drainage not considered wild or scenic. Coastal zone management and active agriculture and/or forest preservation efforts could significantly affect development if such programs were implemented. On the whole, however, the amount of projected baseline population increase, the amount of undeveloped space in the Regional Study Area, and the relatively small amount of land potentially subject to State regulation in either State indicates that these constraints will affect development to a relatively small degree.

County/Local Government

2.505
The enactment of zoning and subdivision controls by local and county governments is expected to continue to have the greatest institutional impact on land use in the Regional Study Area. Through zoning and subdivision ordinances, localities or counties can control the quality, location, and type of development by their review/approval requirements. The effect of these ordinances will continue to be dependent upon their content and how strictly they are applied. The pattern to date appears to have been one of relative leniency, with less stringent regulations in Ohio and zoning changes in Pennsylvania. A comparison of several municipalities, as shown in Table 2-304 in Pennsylvania amplifies the latter point. Erie is a fairly well established (subdivided) community, while Millcreek has seen a very rapid growth in recent years. Fairview and Girard are still rural in character with much lower population densities. Yet, the zoning changes in Millcreek are of the same order of magnitude when compared with the more rural townships if one considers the number of changes granted per number of individuals in the locality. Granted variances, which do not show up on the zoning map, can have a similar effect to zoning changes. There are indications that a less lenient attitude is developing in localities where rapid growth is a perceived problem (e.g., Springfield Township), but there is no

Table 2-304

Rezoning Requests/Grants for Selected Communities

	No. of Rezoning Requests from 1970 to 3/1975	No. of Requests Granted from 1970 to 3/1975
Girard Township (20,427 acres) Pop. 8,500	33	23
Fairview Township (17,501 acres) Pop. 6,150	13	8
Millcreek Township (18,676 acres) Pop. 39,000	223	121
City of Erie (11,311) Pop. ~180,000	144	44

Source: Pennsylvania Coastal Zone Resources Analysis for Lake Erie.

apparent regional trend in this direction, nor is one predictable. It is likely that if such a trend develops, it will be manifested at the local rather than county level, since the "home rule" philosophy is well established in the region. Non-zoned areas can have even greater problems, as they have less formal control over basic development types and location (the county still reviews subdivision). However, as in Springfield, development pressure is expected to encourage revised zoning in some areas and new zoning in others. The greatest effect of population increases will probably be felt around existing population centers, spilling over into neighboring municipalities as on-lot sewage and water or public facilities allow. Projected baseline population increases could have a marked effect on the character of transitional rural areas (e.g., Kingsville, Girard, etc.) if existing local institutional tools are not exercised. While there will probably be an increase in suburban residential and commercial-type use designations in the more rural areas, and perhaps an increase in industrial uses, the region has enough open land to absorb projected baseline increases without significant changes in the character of most localities if existing land use constraints are followed.

Physical Environment

Terrestrial Regime

Regional Geology

2.506
The data contained in this section are based on regional and site specific geotechnical investigations conducted jointly by D'Appolonia Consulting Engineers, Inc. and Haley and Alrich, Inc. (2-111). The objectives of this study were to describe the geology and related geological features of the Regional Study Area; develop a precise geotechnical/geological description of the existing proposed project site; and, relate the site geotechnical/geological conditions to the construction and operation of the proposed steel mill.

a) Physiography

2.507

The proposed site is located within the Eastern Lake section of the Central Lowland physiographic province just north of the glaciated section of the Appalachian Plateaus physiographic province. The Central Lowland is characterized by flat, narrow plains incised by drainage patterns, while the Appalachian Plateaus to the south are characterized by a relatively smooth and gently rolling surface interrupted by a drainage pattern of broad valleys. (2-112, 113)

The surface of the lowland drains north to Lake Erie, while the northern part of the plateau (about 31 miles south of the site) drains both to Lake Erie and south to the Allegheny River. The drainage patterns in both areas are locally controlled by glacial deposits. The present physiography and topography have been shaped by geologic factors including geologic structure, relative hardness of various bedrock strata, and events of the Pleistocene glacial epoch. The transitional zone between the Central Lowland and the Appalachian Plateaus is marked by an escarpment. The actual scarp consists of Mississippian strata, such as the Berea sandstone, which are more resistant than the Upper Devonian shales that underlie the Lake Erie Basin. During the late Paleozoic epochs (about 350 million years ago), the sea that had previously inundated the region withdrew. Throughout the Mesozoic and Cenozoic epochs, the area remained above sea level. (2-114) With the exception of some continental sedimentation and the deposition of the Pleistocene epoch (about one to two million years ago), the predominant process throughout the region has been erosion. Following the withdrawal of the Paleozoic seas, streams became established and began the dissection of the land. Drainage of the region was through stream valleys, with a direction of flow to the north and east in the vicinity of the site came from as far south as central West Virginia by way of the "Old Monongahela System." This former riverine network was disrupted by the Pleistocene glaciations. The ice sheets established the present Ohio River drainage system and scoured out the large basins which are occupied by the present-day Great Lakes. Continental glaciation associated with climatic changes some one to two million years ago resulted in several district ice sheet advances into the northwestern Pennsylvania/northeastern Ohio area. During these advances, materials were picked up locally and from places to the northeast and carried along for varying distances before being deposited largely as glacial till, an unsorted, unstratified heterogeneous mixture of clay, silt, sand, gravel, and boulders. As the last ice sheet retreated, a series of proglacial lakes developed in the main Erie Basin. (2-115, 116) The result is the presence of a widespread blanket of lacustrine deposits and localized beach deposits. Immediately following deglaciation of the Erie Basin, about 10,000 to 12,000 years ago, the ancestral lake emptied through a channel created by exposure of the Niagara escarpment near Buffalo, New York. This event coupled with the separation from Lake Huron drainage caused the Lake Erie level to stabilize about 131 feet below the present stage of 570.4 feet. However, the low level was short-lived as postglacial isostatic rebound raised the lake outlet at Buffalo, New York. An intermediate level of between 33 to 66 feet below present stage was maintained from about 10,000 to 6,000 years ago. A sharp rise occurred between 5,000 and 3,800 years ago due to the additional rebound at the outlet. The sharp rise and reintroduction of flow from Lake Huron caused the gradual rise to present-day

levels. Throughout most of the last 12,000 years, the present land surface has undergone erosion by rainfall, streamflow, and other agents. Surface erosion has reduced the thickness of the surficial lacustrine deposits and has cut ravines in some places, as the underlying bedrock.

b) Stratigraphy

2.508
The geologic units underlying the site and the region include both Quaternary deposits and bedrock of Paleozoic age. The chronology and stratigraphy for the region is provided in Table 2-305. The region has been greatly influenced by glaciation and the various proglacial lakes established during the ice sheet recession. The Upper Devonian shales were beveled by the erosion of the ice sheets prior to and during deposition of the two till units (an upper till and a lower till) found at the proposed Greenfield site. These units are believed to be associated with the Lake Cary-Lake Escarpment Moraine System. The Paleozoic rock units for the proposed site and surrounding region were identified during this study through mapping and stratigraphic column analysis. A composite geologic map identifying the rock units and contacts for both Ohio and Pennsylvania is presented in Figure 2-69, while the generalized stratigraphic comumn identifying the units from the surface to the Precambrian basement rock in the vicinity of the proposed site is presented in Figure 2-70.

c) Structure

2.509
The near-surface bedrock strata are essentially horizontal with only minor structural features. Regionally, the bedrock dips gently to the south at approximately 50 feet per mile or less. (2-117) Locally, however, numerous small anticlinal folds have been observed. The folds are sharply arched so the dips are great on both sides of the anticlinal axis. Within about 66 feet to 98 feet of these features, the strata are essentially horizontal again. Several of these small anticlinal structures are broken by small faults with a displacement of a few centimeters. The joint systems prominent in shales underlying the glacial drift have been measured, and two joint sets were found to be prominent throughout the northern part of Ashtabula County. The sets trend N40°E and N55°W, respectively. In the vicinity of the site, the top of the bedrock generally rises to the south, away from the lake, and toward the bedrock escarpment to the south. The subsurface structure is similar to the surface structure. The regional strike is N75°E with a gentle dip to the southeast. Only minor folds of low relief and small displacement faults interrupt the continuity of the structure. In the vicinity of the

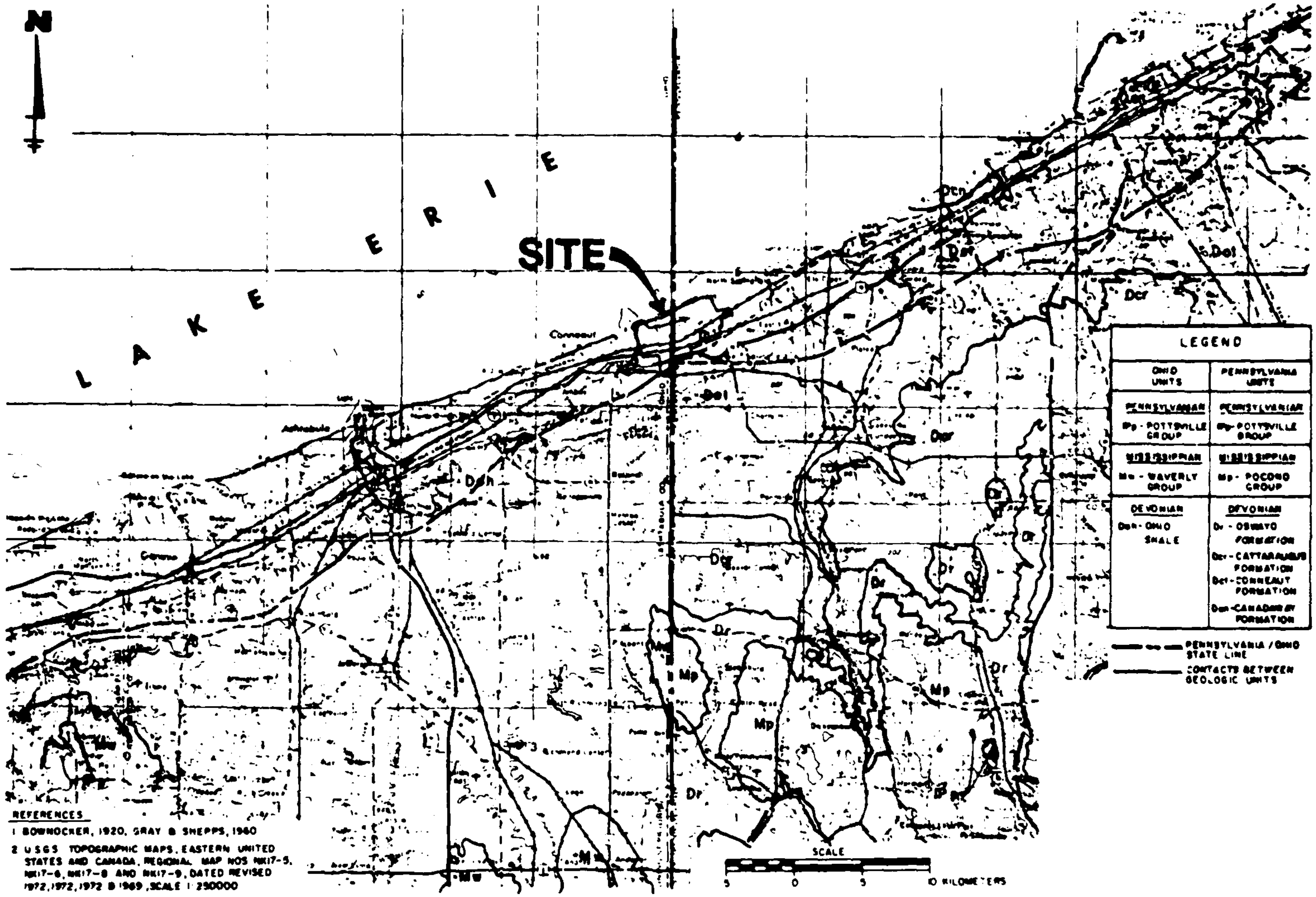
Table 2-305

Quartenary Chronology and Stratigraphy

Stage	Substage	Unit	Moraine	Proglacial Lake	Lake Erie	Elevation (Meters)	Elevation (Feet)	Approximate Age in Years Before Present
					Modern Lake Erie	173.7	570	
					Early Lake Erie	143.3	470	12,000
				Lake Dana[1]		178.3	585	
				Early Lake Algonquin[1]		184.4	605	
				Lake Lundy[1]		188.9	620	
Wisconsinan	Woodfordian (Last Wisconsinan) Port Huron			Lake Grassmere [1]		195.1	640	
				Warren III		202.7	665	
				Warren II		204.2	670	
				Warren I		207.3	680	
				Whittlesey		224.0	735	12,800
			Lake Escarpment System:					
		Ashtabula Till	Girard Ashtabula Painesville Euclid	Maumee III		237.7	780	13,600
				Maumee II[1]		231.6	760	
				Maumee I[1]		243.8	800	
		Hiram Till	Defiance					
	Cary	Lavery Till	Lavery					
		Kent Till	Cleveland					
	Farmdalian							
	Altonian (Early Wisconsinan)	Titusville Till						
Sangamonian								
Illinoian		Mapledale Till						
Pre-Illinoian		Slippery Rock Till						

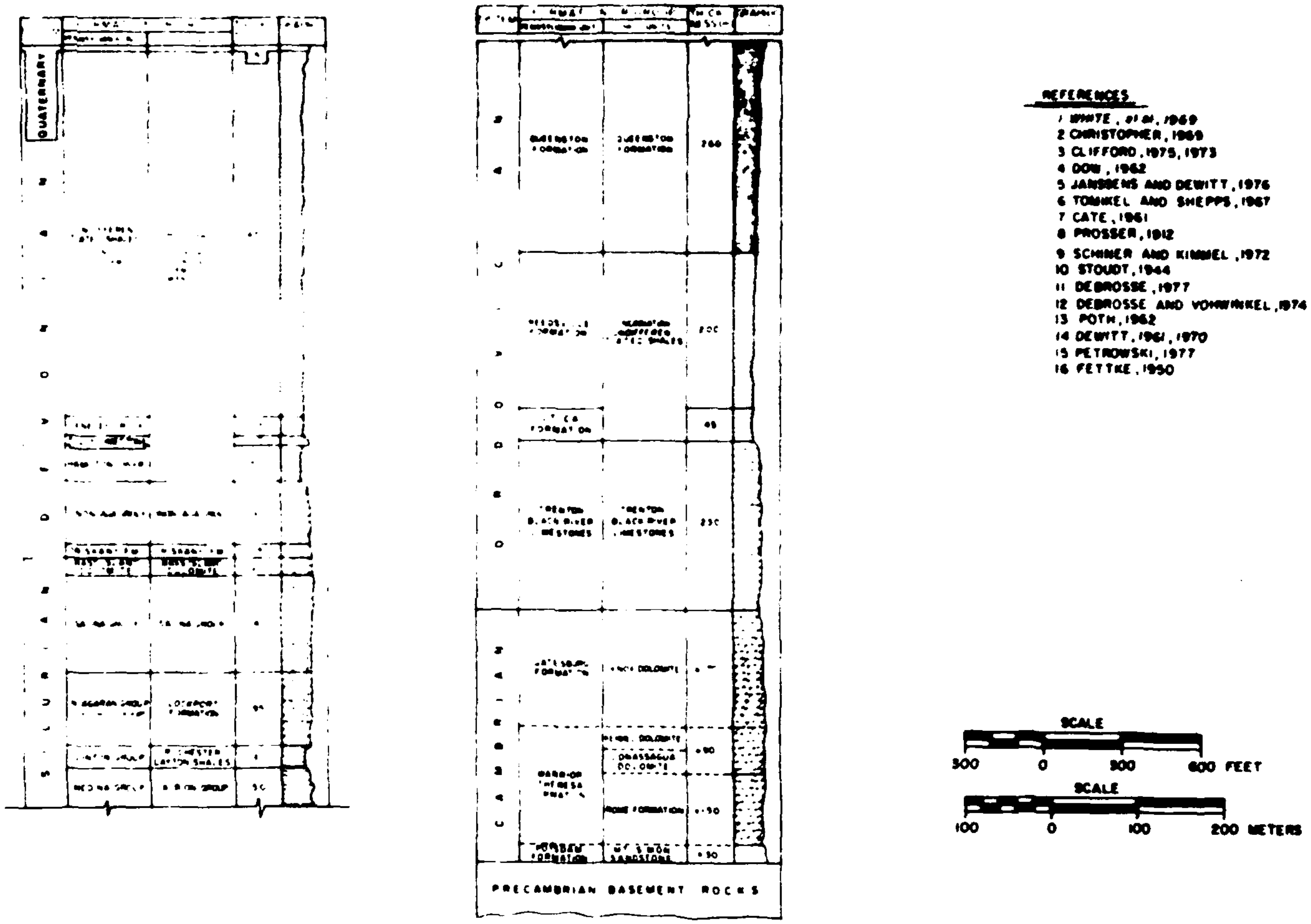
(1) Deposits not known to be present in northwestern Pennsylvania.

Source: [illegible] Hales & Aldrich Joint Effort.



Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–69 GEOLOGIC MAP OF THE PROPOSED LAKEFRONT PLANT SITE



Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–70 GENERALIZED STRATIGRAPHIC SECTION OF THE PROPOSED LAKEFRONT PLANT PROJECT AREA

site, the presence of salt deposits has locally emphasized the structure producing small closures that have, in some cases, been exploited for natural gas. (2-119) No major faulting is known to be present in the immediate region.

d) Geologic Hazards

2.510
Geologic hazards that have been considered with respect to the proposed plant site include earthquakes, landslides and slumps, subsidence, fast land erosion, and shoreline erosion.

Earthquakes

2.511
The proposed plant site is located within the "Zone 2" region of the United States. An area which is defined as having a moderate seismic risk, moderate damage corresponding to intensity VII of the Modified Mercalli Intensity Scale of 1931. This intensity is equivalent to a definitely noticeable event with negligible damage to buildings of good design and construction. The epicenters of earthquake events for a period from 1857 to 1974, and their respective Modified Mercalli intensity has been for several thousand square kilometers around the site. The reported earthquake event nearest the proposed plant site occurred in 1934 about 15 miles to the east near Erie, Pennsylvania. The two largest recorded earthquake events in the region occurred about 127 miles northeast of the site, near Batavia, New York, 19 miles east of Buffalo, and about 221 miles to the west near Anna, Ohio. These events had Modified Mercalli intensities of IX and VIII, respectively. The number of earthquake events near Buffalo is believed to two basement structures identified with a west-trending structure crossing western New York and Ontario and the north-trending Clarendon-Linden structure. (2-118) The earthquakes near Anna, Ohio, may be related to adjustments along the Cincinnati-Findlay Arch, another basement structure. (2-118, 119) Review of epicenters identifies the site area as having infrequent relatively low intensity (less than intensity V) events. The earthquake hazard analysis shows the site to be in a location where there is a 90 percent probability that a horizontal acceleration of four percent gravity will not be exceeded in a 50-year period. It also shows that the maximum expected horizontal acceleration at the site is nine percent gravity.

Landslides and Slumps

2.512
Review of the geologic literature and reconnaissance in the Regional Study Area indicates that, with the exception of the shoreline zone, landslides and slumps are not severe problems due to the relatively

flat topography, geologic conditions, and present land use. Landslides and slumps may occur along creeks such as Conneaut Creek, Turkey Creek, and Raccoon Creek, especially in the more deeply incised areas. There is some evidence of this type occurrence in the lower reaches of Turkey Creek. Landslides and slumps are present at various locations along the shoreline between Ashtabula, Ohio and Presque Isle, Pennsylvania. Failures typically occur as a result of oversteepening of the bluffs by waves. The glacial till deposits attain very steep slopes until large blocks of material separate from the bluffs along stress relief induced fractures. Where the lacustrine clays and sands compose large thicknesses of the bluff, the amount of water present is the factor that determines whether landslides, slumps, or mudflows will occur. Landslides or slumps may also occur in conjunction with large intensity seismic events, however, no evidence exists in the literature documenting such occurrences locally. The predominance of compact glacial till at the site and in the region suggests that liquefaction is not a limiting or constraining factor.

Subsidence

2.513
Subsidence due to natural or manmade causes is not a major concern in the region. There is a general lack of underground mining (except for salt in the Cleveland, Ohio area), significant groundwater and petroleum withdrawals and other manmade conditions that could in time result in subsidence. Natural factors such as limestone solutioning and collapses in soil structure are typically not present.

e) Economic Resources

2.514
The present and potential mineral resources of the region were identified through a search of the literature. These include oil and gas, sand and gravel, stone (building, riprap, crushed), salt brine, clay, and peat. The immediate region lies stratigraphically below the coal measures of the Pennsylvanian rocks and no indication of coal or metallic deposits was found in the numerous oil and gas wells drilled in the area.

Oil and Gas

2.515
No producing oil wells were recorded in the vicinity of the site, although there have been oil traces in several formations. The nearest large producing oil field to the site is the Mecca field in central Trumbull County about 40 miles south of the site. (2-120) Some smaller fields are also present in Ashtabula County. (2-121)

Since gas is usually found geologically updip from the oil and the rocks in general dip to the south, more gas-producing wells would be expected in this region. Numerous gas pools are noted in Ashtabula and Erie Counties, including the Bushnell gas pool (believed to be depleted) under the site. To date, virtually all drilling and discoveries have been onshore since the States of Pennsylvania, Ohio, and New York do not permit drilling offshore. There are several producing wells on the Canadian side of Lake Erie, indicating the possibility of potential gas reserves underlying Lake Erie. The major gas-producing formation on the Canadian portion of Lake Erie is the Lower Silurian Clinton Group. (2-121)

Salt Brine

2.516
There are several sources of salt and salt brine in the area. The Silurian-Salina Group contains several strata of halite, and several other units contain brine, including the Oriskany Formation, Medina Group, Trenton-Black River Limestones, and the Gatesburg Formation. (2-113) The brine probably represents sea water trapped in the deposits when they were initially formed. The evaporite deposits are not presently exploited in the immediate vicinity of the site. At present, the Salina Group is mined by Morton Salt Company near Grand River in Lake County, Ohio. (2-121, 122) There are no producing salt brine wells in Erie County, Pennsylvania although exploratory wells have been drilled. (2-113)

Sand and Gravel

2.517
There are numerous sand and gravel borrow pits in the Conneaut area, ranging from large commercial operations to small individually owned borrow pits. Most of the areas of potential sand and gravel are in strand deposits created around the edges of the proglacial lakes. In 1975, Ashtabula County produced 67,300 cubic meters (88,000 cubic yards) of sand and gravel, the majority from proglacial strand deposits. Only one operation recovered sand and gravel from river deposits. (2-123) There has been little production of sand and gravel deposits on land in Erie County in recent years. (2-124) Production is relatively low because the gravel fraction typically does not weather well due to its shale, claystone, and/or siltstone origin.

Stone

2.518
Stone from the region has been used in the past as building material, crushed stone aggregate, and riprap. Building stone is no longer quarried in the region, but stone for aggregate uses has been mined

at some quarries. The material that was previously obtained consisted of sandstone from the following geologic units: (2-113, 125) Panama Sandstone; Canadaway Formation; LeBoeuf Sandstone; Upper Conneaut Formation, and Cussewago Sandstone. The first four units are thin sandstone members of the Upper Devonian Age. The Cussewago Sandstone is the basal member of the overlying Mississippian rocks that outcrop several kilometers to the south. The Upper Devonian bedrock in the region consists of inter-bedded shales and thin sandstones. The shales are not considered a good source of aggregate or riprap because of their susceptibility to rapid weathering. Typically, the sandstone layers are not thick enough to be quarried for riprap. As a result, transportation costs for stone aggregate and riprap are high since the closest thick sandstone unit is in the Berea Formation approximately 20 miles from the site. (2-126)

Clays

2.519
In the past, the Upper Devonian Chagrin Shale has been mined, crushed, and used as a clay source by the brick industry. These brick yards and clay pits are apparently no longer in operation. (2-127) In addition, small deposits of clay may be found in the glacial tills, although none has been exploited to date. (2-128)

Peat

2.520
No peat is being commercially extracted at this time in Ashtabula County although it was the second most valuable natural resource in Erie County in 1973. At present, most of the peat is taken from areas near Cory which is located in the southeastern portion of Erie County. Reserves of peat in Erie County reportedly exceed six million cubic yards. (2-113, 123, 124)

f) Shoreline Erosion Features and Erosion Characteristics

2.521
Lake Erie is the shallowest of the Great Lakes, with an average depth of about 58 feet and a maximum depth of about 165 feet. Its southeastern shoreline between Ashtabula, Ohio, and Presque Isle, Pennsylvania is classified as "high bluff erodible" by the U.S. Army Corps of Engineers. The bluffs range in height from less than seven feet to over 83 feet. The shoreline environment is one of relatively high energy, so it is in a constant state of change. As a result of long-term (several years), intermediate-term (seasonal) and short-term (several hours to a few days) high lake levels, wave action, and a diminishing sand supply, the bluffs have been extensively eroded. Beaches of varying width and elevations consist both of material

derived from the erosion of the bluff immediately above and of material carried to the beach by the longshore drift, and deposited. Throughout the area longshore transport is predominantly eastward. Thus, although beach material is continually being lost by wave action, the beach is being replenished by material supplied by shoreline erosion to the west.

Shoreline Sediments

2.522
The bluffs along the shoreline of the regional study area are the primary sediment source for materials in the littoral zone. Other sources are minor (such as existing nearshore and offshore deposits and influxes of sediment from streams draining to Lake Erie). Coarser sediments (sand) tend to remain in the littoral zone; the finer sediments (silts and clays) are generally transported offshore.

Nearshore and Offshore Deposits

2.523
The nature of the shoreline is such that large nearshore or offshore deposits are not typically available to the littoral zone. No positive evidence has been identified for the shoreward movement of sediments from the deeper basin areas.

Streams

2.524
The major streams between Ashtabula, and Erie reportedly contribute little or no sediment suitable for the beaches. (2-129, 130) This is caused by the nature of the sediments in the watersheds, the downstream channel characteristics, and the presence of breakwater facilities. The predominant lithologies through which the streams drain are the fine-grained glacial tills and the dark shale bedrock. Consequently, the majority of sediment produced is fine-grained silts and clays which are not important constituents of the beaches. Relatively small amounts of coarser-grained materials are reportedly trapped in either the broad river mouths (2-130) or in the harbors formed by the breakwaters. (2-129) Many of the smaller streams have similar conditions of broad lower reaches which act as settling basins for the small amounts of relatively coarse-grained material that would otherwise be incorporated into the beaches.

Bluffs

2.525
The bluffs in the regional study area are the major contributors to the Lake Erie littoral system. Estimates indicate that up to 20 percent of the materials eroded from the bluffs are suitable for beach

building with the remainder lost possibly through dispersion into the deeper offshore zones (2-129). The stratigraphy of the bluffs in the area between Ashtabula, Ohio, and Presque Isle, Pennsylvania, is fairly uniform with respect to sequence of rock units, though their thickness may vary. In general, the bluffs are made up of the following major lithologic types: poorly cemented lacustrine sand, massive laminated and nonlaminated lacustrine clay, silt, and sand, glacial till, and shale. Generally, the sand deposits occupy the topmost section of the bluff and reportedly range from three to 33 feet in thickness between Ashtabula and Conneaut. Their thickness east of Conneaut to Presque Isle, ranges from little or no sand to about 17 feet. The lone exception to the above identified stratigraphic position of the sand units is in the border area of Ashtabula and Kingsville Township, Ohio where 17 feet of sand underlies seven to 17 feet of glacial till. (2-129) The massive lacustrine clays consistently underlie the sand deposits. The thickness of the clays varies from less than one meter to as much as 10 meters (33 feet). Glacial till underlies the lacustrine clays and, on a regional basis, is the dominant lithologic type. The till composes virtually the entire bluff at several locations between Ashtabula and Presque Isle. Underlying the glacial till are the Upper Devonian shales. These units are exposed at the base of the bluffs only at limited locations. Farther to the east of Presque Isle, the shales constitute the major lithology of the bluff.

2.526
The degradation processes operating on the bluff include chemical and physical weathering, mass wasting, and erosion by wind and water. Weathering in terms of freezing and thawing, oxidation, hydrolysis, hydration, and solution is most effective on the tills and selected silt-rich lacustrine deposits. Freezing and thawing cycles result in distinct nonelastic movement of the soil. On heaving, the movement is directed outward and normal to the slope. However, during the thawing process, the force of gravity is not sufficient to return the soil to its original position, so the volume is increased in the process. This increased volume is naturally accompanied by at least a temporary increase in moisture content, which produces a reduction in the cohesive strength of clays and the internal frictional resistance in granular soils. For a partially thawed condition, the still-frozen layer below blocks drainage of the meltwater and a detrimental buildup of hydrostatic pressure can occur. Under this type of condition, the soil moves downslope under gravitational force. (2-131) If exposed on or near the bluff, minerals such as hematite and pyrite are hydrated to limonite; feldspars and micas are hydrolyzed to clay minerals; and carbonate-rich materials are leached into solution. The net effect is that these processes increase the bulk and loosen the weathered bluff materials, especially the glacial tills, and render them more susceptible to mass wasting. (2-129) Mast wasting

of the bluffs ranges from sand grains falling downbluff from their outcrop, to the vertical collapse of massive blocks of till, and from small mud flows to extensive slumps. This process operates most effectively in the till and lacustrine clay of the bluffs and is aided by the weathering and erosional processes. Erosion is caused primarily by rainfall runoff, groundwater seepage, and by wave action removing material and incorporating it into the littoral drift. Wind erodes the sandier materials during the dry months. Of the above processes that act on the bluff deposits, erosion by waves is by far the most important. Without the associated undercutting and oversteepening of the bluff, the other processes would quickly establish a stable slope-versus-lithology condition.

Nature of Transported Sediment

2.527
Once mass-wasted materials are introduced into the littoral zone, wave energy disperses the unconsolidated sediments, washes out the finer particles, and transports the coarser fraction along the beaches as natural downdrift beach replenishment material. Thus, the lithology of the material comprising the bluffs is an important factor in determining the availability of sediment for beach development along the southeastern shore of Lake Erie. Studies indicate that material finer than a No. 140 sieve (0.106 millimeters) does not contribute to beach building under the wave exposure and current conditions present along the southeastern shore of Lake Erie. The fine-grained silts and clays which comprise the greater percentage of the material supplied to the nearshore zone are suspended and gradually dispersed offshore during wave activity. This dispersion is evidenced by the high turbidity levels of the nearshore waters during periods of high wave activity and following large storms. These clays and silts are then carried offshore to more quiescent depositional environments in the deeper basins of Lake Erie. One estimate indicates that approximately 0.4 million tons per year of fine-grained sediments are removed from the Erie County Lake Erie shoreline and subsequently deposited offshore in low-energy basins.

Coastal Processes

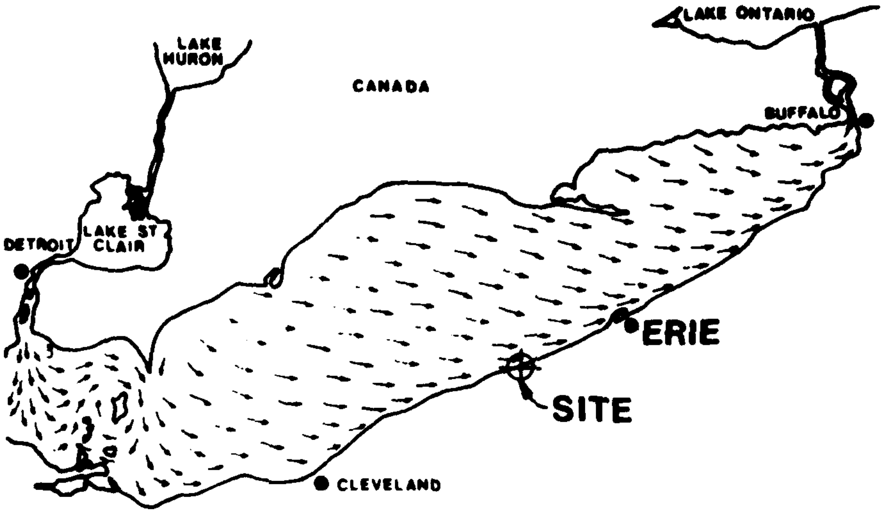
2.528
Waves and the longshore currents induced by them are the more important processes active in the shoreline zone. Other elements (chiefly lake level fluctuations, storms, lake ice, beaches and manmade structures) dictate the relative impact of wave action at any particular time.

Waves

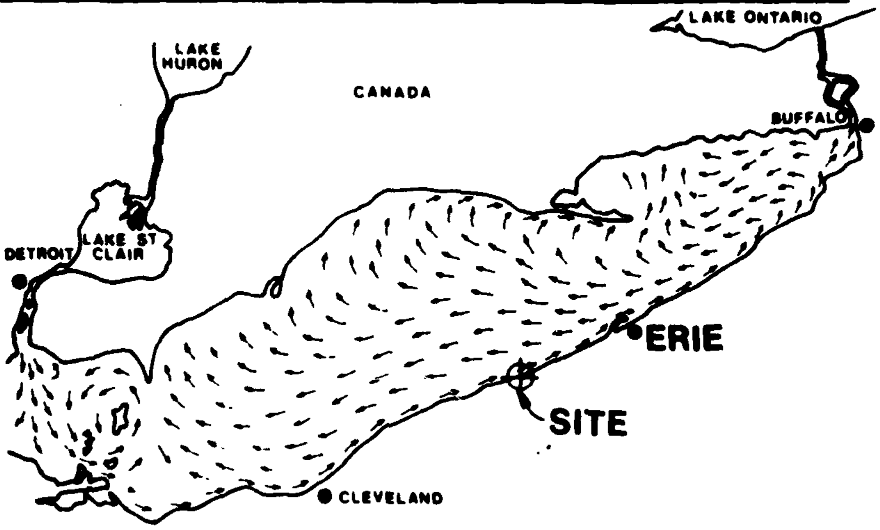
2.529
Wind-generated waves on Lake Erie are responsible for the alterations in shoreline morphology and for the generation of longshore currents. The rates at which waves deliver energy and momentum to the shore (energy and momentum fluxes) are functions of the wave height at a given depth, the wave period and the angle between the wave crest and the beach. The momentum carried by the breaking waves feeds the longshore currents (refer to Figure 2-71) which in transport eroded beach sediment parallel to the shoreline. (2-132) The dominant and prevailing winds blow from the southwest, west and northwest along the long axis of the lake, suggesting that the currents and net wave energy flux are oriented eastward. Results of model studies support this inferred longshore current direction on a regional basis. Locally, the eastward littoral flow orientation is evidenced by the buildup of sand along the western sides of piers, groins, and other structures located offshore between Ashtabula, Ohio, and Presque Isle, Pennsylvania. The annual wave energy flux data for Cleveland, Ohio; Erie, Pennsylvania; and Buffalo, New York, based on hindcast wave conditions is summarized in Figure 2-72. The diagram for Cleveland shows some dominance from the northwesterly direction, but otherwise a relatively uniform energy flux distribution from all directions. At Erie, the wave energy flux from the west is more pronounced as the westerly fetch length increases and the easterly lengths decrease. At Buffalo, the mean annual wave energy flux is generally restricted to the west-southwest approaches. A significant increase in the magnitude of wave energies occurs at Buffalo, compared to those affecting Cleveland or Erie, due primarily to its location and fetch lengths with regard to the predominant wind direction. The three wave energy flux diagrams shown in Figure 2-72 emphasize two important points related to the shoreline processes active on the southeastern shore of Lake Erie: (1) There is a predominant west to east flux of wave energy; and (2) The magnitude of the eastward oriented energy flux component increases from Cleveland to Buffalo.

Beaches

2.530
Beaches dissipate incoming wave energy, acting as a buffer against wave attack and protecting the bluff. Generally speaking, the wider the beach, the greater the protection. Due to its often ephemeral nature, however, a wide beach can provide only temporary protection of the bluff from erosion. If beaches are removed or depleted (for instance, as a result of high lake levels or storms), then subsequent bluff erosion may occur even during periods of light wave action. (2-133)



DOMINANT SUMMER SURFACE FLOW PATTERN IN LAKE ERIE



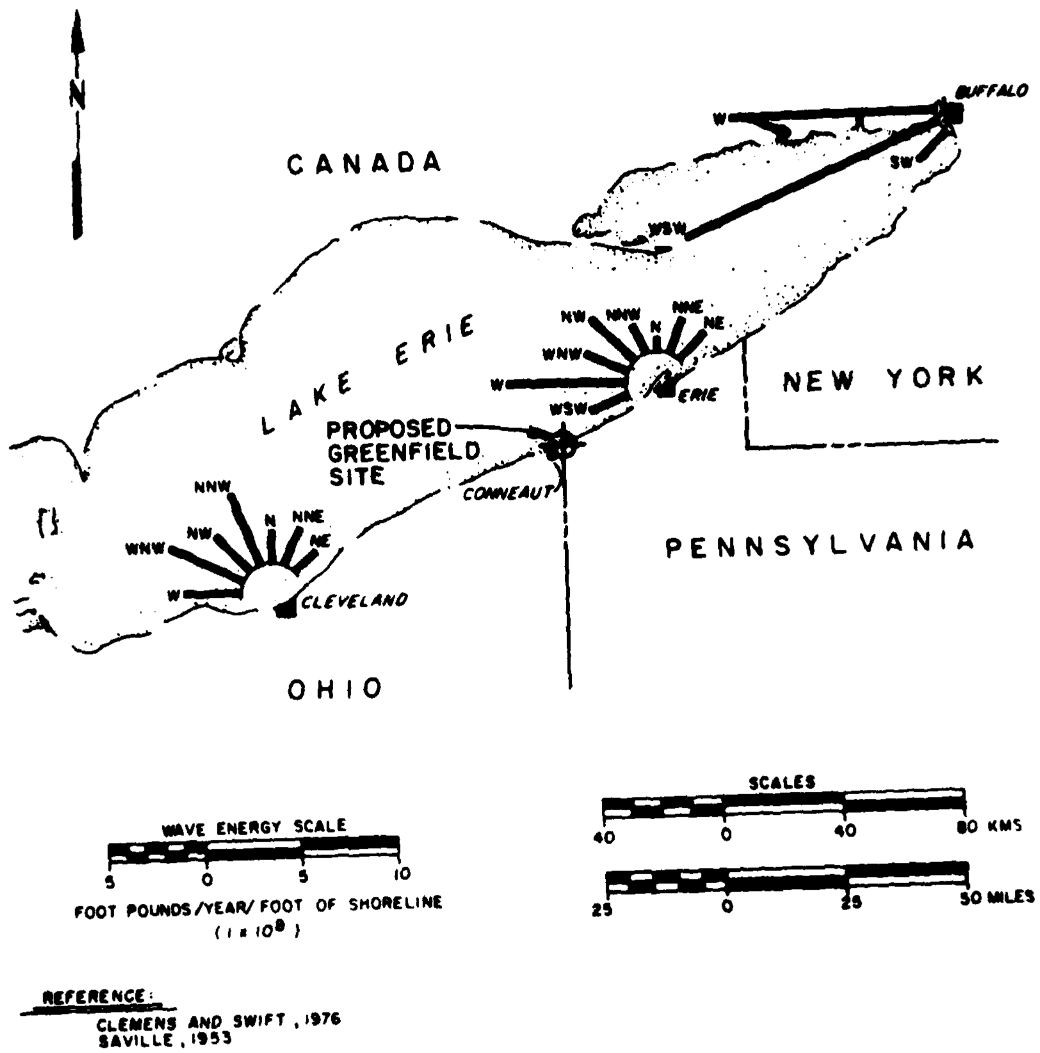
DOMINANT SUMMER BOTTOM FLOW PATTERN IN LAKE ERIE

REFERENCES:

1. LAKE ERIE ENVIRONMENTAL SURVEY, 1968, U.S.D.I. FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, GREAT LAKES REGION.
2. DRAFT ENVIRONMENTAL IMPACT STATEMENT, DIKED DISPOSAL SITE NO. 2 ERIE HARBOR, PA, BUFFALO DISTRICT CORPS OF ENGINEERS, 1974

Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–71 LAKE ERIE CURRENTS



Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–72 WAVE ENERGY FLUX DIAGRAM FOR THE PROPOSED LAKEFRONT PLANT PROJECT AREA

Lake Level Fluctuations

2.531
Lake Erie has fluctuated from a low of 568 feet in 1934 to a high of 573.0 feet in 1973 over the 117-year period of record. Long-term and short-term changes in lake levels, particularly high water levels, have greatly influenced the rates of erosion along the southern shore of Lake Erie. Increased lake levels result in four distinct alterations of the coastal processes in relation to shoreline erosion. These include: alterations in longshore sediment transport patterns; intermittent flooding of low-lying areas; and, intermittent drowning of river or creek mouths. The bluffs along the southeastern shore of Lake Erie are reportedly receding at more rapid rates due to the increases in lake levels in recent years.* Whereas wave energy during low lake levels is dissipated by wider beaches, high lake levels have allowed the waves to directly contact the toe of the bluff. Consequently, the base of the unconsolidated bluffs has been eroded during storm activity and the resultant slope of the bluffs is currently less stable and subject to mass wasting. (2-134) These oversteepened bluffs will continue to experience accelerated erosion and recession of the bluff top even after lake levels drop, possibly for a period of several years or more. The high lake water levels have also caused an alteration in relative onshore-offshore transport of materials. Inundation of existing beaches has resulted in an increase in the net offshore transport of beach building materials. Additionally, recent increases in lake levels have threatened cottages and other structures established during low water years. (2-134) A number of areas along the Lake Erie shoreline in Pennsylvania are subject to severe flood damage. Increased lake levels have also resulted in a raising of the base levels for the streams entering Lake Erie. Although, in some cases, this drowning effect has enhanced the navigability of these streams for small-boat access, the rise in the lake water level has also altered the sediment transport capacities of the streams. By moving the base level farther upstream, deposition of the stream bedload occurs within the embankment and thus does not become entrained in the lake's longshore current. During low or normal lake stages, these materials would be supplied directly to the littoral zone and thus contribute to the replenishment of the downdrift beaches. Another result of this stream mouth drowning is that the velocity of the stream is reduced dramatically as the channel cross section is increased. Consequently, wave energy on the lake may become more dominant than stream discharge, resulting in the formation of bar deposits at the stream mouth which may in turn obstruct the normal flow of the stream.

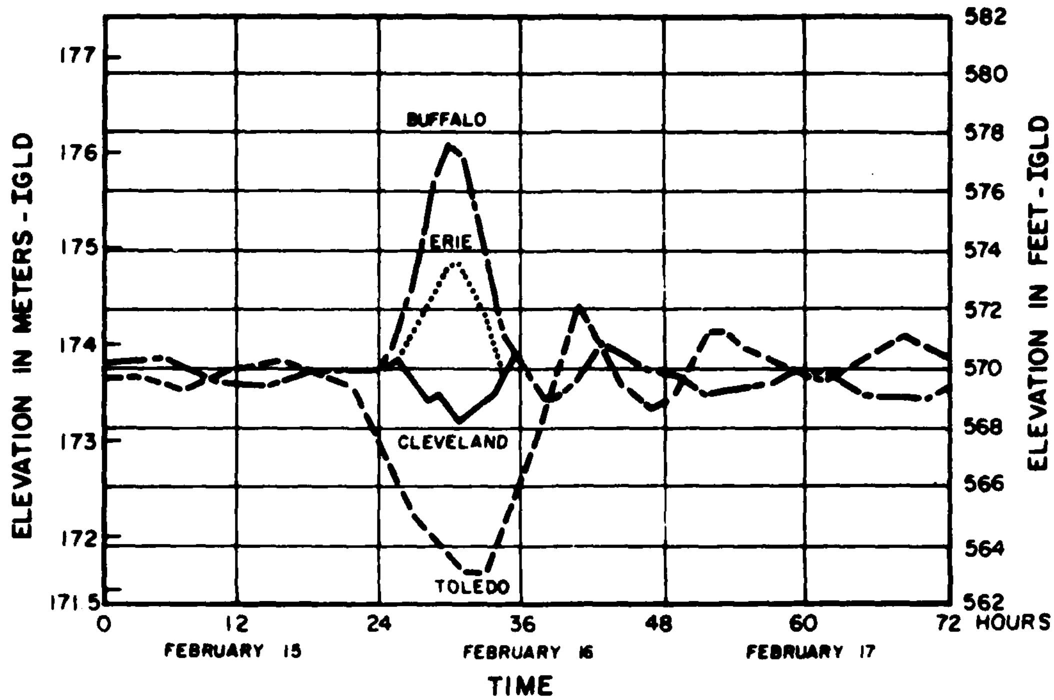
* A quantitative relationship between shoreline erosion rates and lake levels has been developed by the International Great Lakes Levels Board (2-135).

Storms as Erosion Agents

2.532
Storm events contribute significantly to the recession of southeastern Lake Erie shoreline; a single storm during periods of high water levels can erode away as much land as is normally eroded within a period of several years. (2-136) The most critical type of storm events are associated with large wind-induced differences in lake levels. These wind set-ups and related seiches are common on Lake Erie due to the shape of its basin and its alignment to the predominant storm tracks. Strong winds oriented along the axis of the lake due to the passage of a low pressure center north of the lake cause a net movement of water toward the northeast end of the lake. The result is typically an increase in lake elevation at Buffalo and a corresponding decrease in lake level at the western end of the lake at Toledo. An example of this phenomenon is presented in Figure 2-73. This wind set-up phenomenon is critical to shoreline recession rates, because the highest winds generally blow along the long axis, the maximum fetch length of the lake. Consequently, the conditions for a large wind set-up are identical to those resulting in maximum wave energy at the eastern end of the lake. Therefore, not only is the lake level increased at the eastern end, but the wave heights superimposed on these high lake levels are near or at their maximum, resulting in an increased destructive power. The effect of these wind set-ups is less severe or nonexistent at locations near the middle of the lake (where the proposed site is located) because of the existence of a nodal point for oscillations of lake level in this vicinity and thus the greatly reduced lake water level fluctuation.

Ice

2.533
Ice has both a detrimental and beneficial effect on the shoreline of the regional study area. Some of the phenomena of winter icing, such as ice volcanoes, may be associated with locally accelerated beach erosion. (2-137) Ice volcanoes are generated by spray and solid ice ejected at the landward ends of channels into shorefront ice and are most likely accompanied by a focusing of wave erosive power on the bottom near their base. During spring breakup of the ice, the shoreline, and various manmade structures can be badly damaged by the ice. The beneficial aspect of ice is the protection it offers during the winter months. In the late fall, wave spray freezes and produces an effective armoring of the shoreline which prevents significant erosion for the duration of the winter. Additionally, extensive ice cover on the lake reduces wind fetch and thus greatly inhibits the building of large erosive storm waves. However, during mild winters the protective value of ice is diminished resulting in accelerated erosion.



REFERENCE:
U.S. LAKE SURVEY, 1976

Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

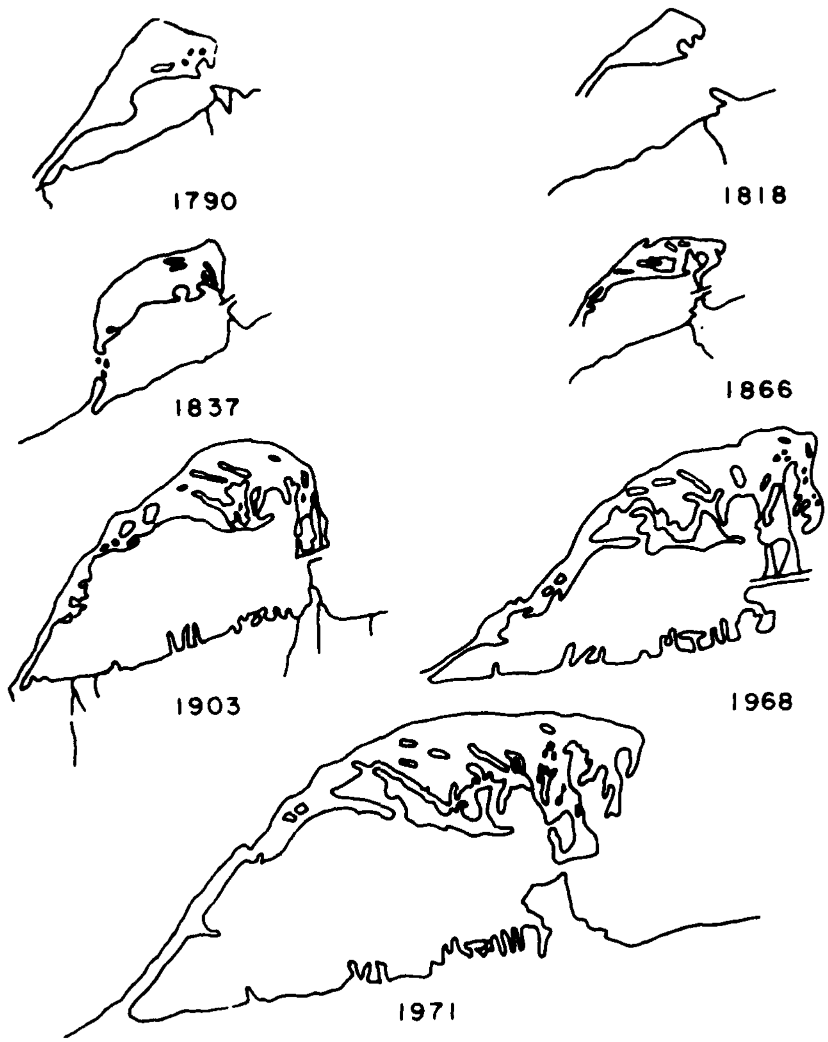
FIGURE 2–73 LAKE ERIE WATER LEVEL FLUCTUATION
STORM OF 16 FEBRUARY 1967

Control Structures

2.534
Control structures have been emplaced along the southeastern shore of Lake Erie during the past 150 years to accomplish one or more of the following purposes: provide protection of onshore structures and property; assure navigable access ways; enhance docking facilities; and provide and/or protect recreational beaches. Protective structures have various effects on the local shoreline recession rates, depending on the size, type, and orientation, and the local littoral environment. The various types of control structures found in this coastal portion of the regional study area include: seawalls, revetments, and beach accretion devices, such as groins and offshore breakwaters. Structures oriented perpendicular to the shoreline (such as groins or seawalls) or extending offshore into the breaker zone generally have the most effect on regional coastal processes. These structures tend to intercept longshore currents and to alter the littoral drift with deposition occurring adjacent to the updrift side of the structure. The interception of drift material may reduce replenishment rates downcurrent of the structure causing erosion to accelerate. A great many control structures have been placed along the shoreline. Although the largest structures are breakwaters protecting Ashtabula Harbor and Conneaut Harbor, fairly significant jetties and/or groins have also been placed at the mouths of Elk Creek and Walnut Creek. Additionally, numerous small groins have been constructed by private landowners to protect their property. East of Conneaut, these groins may be of limited effectiveness, as littoral transport may be so light that the desired beaches accrete very slowly and are easily removed by storms.

Natural Shore Processes

2.535
The only natural shore process within the Ohio-Pennsylvania Regional Study area is the Presque Isle peninsula. It is located about 20 miles east of the proposed project site and is considered unique in terms of recreational potential, geology, and ecology. Presque Isle is a relatively recent geologic feature, having developed less than 13,000 years ago after the final retreat of glacial ice from this area. The peninsula, approximately six miles long and is composed of sand deposits brought into the area from the west by the littoral current. Except for the periods of 1790-1818 and 1837-1866 when the peninsula diminished, Presque Isle has grown so that presently the neck is about three times longer, the exposed land area three times greater than in 1790, as shown in Figure 2-74. Over the years there has been "a persistent movement of the entire peninsula in a northeasterly direction, growth at the distal end, and recession of the lakeside beaches at the shoreward end. (2-138) The eastward



Source: U.S. Army Corps of Engineers.

FIGURE 2–74 THE DEVELOPMENT OF PRESQUE ISLE SINCE 1790

growth of the landform sequesters small ponds, thus forming a sequence of bodies of water of different age. At present, four natural forces apparently combine in the complex development of the spit: the littoral current bearing beach material, wave action that turns the spit inward to form a hook, northeasterly storm winds causing the building of ridges, and the effect of wind and vegetal cover to build dunes and soil. In recent years, the natural supply of sand and gravel to Presque Isle from updrift areas probably has declined, partially due to the presence of manmade control structures updrift from the peninsula. Also, many of the local streams which in the past contributed granular material to the littoral zone are narrow streams that have eroded down to the underlying shale, thus reducing the availability of granular material. It is possible that the natural erosion of the western beaches on the neck of the peninsula has been aggravated by this recent reduction of available beach material. Despite its history of overall growth, a great deal of time, effort, and money has been spent in an attempt to stabilize this unstable landform. In recent years storms have repeatedly breached the narrow neck of the peninsula, carrying away beach material and undermining and damaging the road. Damage resulting from the storm of 5 December 1968, for example, was estimated to be $2,000,000. (2-139) The completion of the first phase of the Federal Government/Commonwealth of Pennsylvania Cooperative Beach Erosion Control Project in 1956 entailed the restoration and improvement of approximately five miles of lakeward shoreline including the placement of about 3.2 million cubic meters of sand, the construction of 10 new groins, the alteration of two existing groins, and the rebuilding of 900 meters of seawall at a total cost of $2,451,000 with a Federal contribution of $817,000. In spite of these efforts, artificial beach nourishment has been required almost annually (refer to Table 2-306). Most recently, (as part of the 1975 Cooperative Beach Erosion Control Project) the U.S. Army Corps of Engineers has proposed that three partial breakwaters be constructed 1,000 feet offshore along the north shore of Presque Isle, as shown in Figure 2-75, to combat erosion. In addition to protecting the harbor of the city of Erie and to its scientific interest noted earlier, the Presque Isle peninsula is a recreational resource. Nearly all of the peninsula's 4,250 acres is owned by the Commonwealth and is developed as Presque Isle State Park, providing facilities for bathing, boating, hiking, fishing, and picnicking. Three to four million visitors are served annually by the Park and contribute an estimated $65,000,000 per year to the local economy. (2-139) The site is also of historical importance because it is associated with Perry's great victory of the Battle of Lake Erie in the War of 1812 and an historic museum is planned at Misery Bay.

Table 2-306

History of Beach Nourishment for Presque Isle

Year	Volume in Cubic Yards
1956	$4,200,000[1]
1957	-
1958	2,000
1959	20,000
1960-61	681,500
1962-63	-
1964-65	434,300
1966	45,000
1967	-
1968-69	68,500
1970	-
1971	118,000
1972	60,000
1973	100,000
1974	-
1975	149,600[2]
1976	146,400[2]
1977	193,300[3]
Sum	6,218,600
Annual Average, 1956-77	282,660
Annual Average, 1957-77	100,930

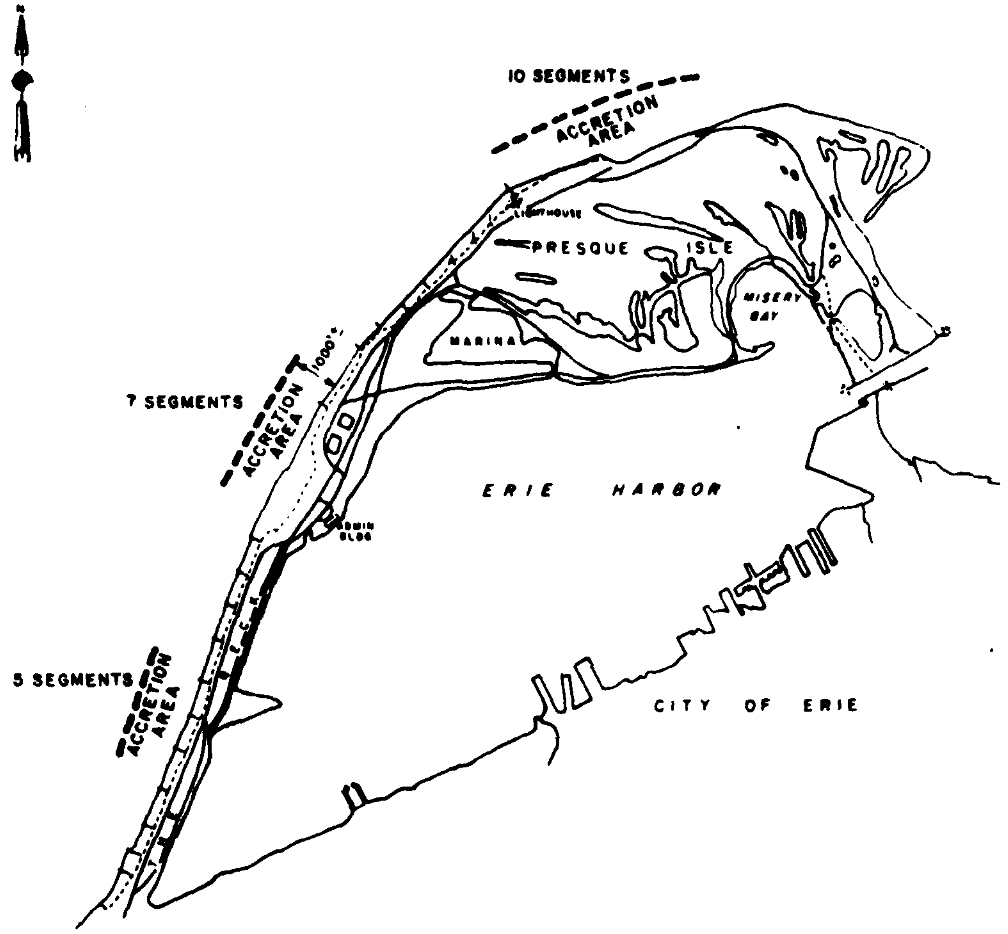
(1) This volume includes the initial beach restoration and the material for the two feeder beaches.

(2) These numbers were converted from estimated tonnage using a unit weight estimate of 1.25 tons per cubic yard. The source of the sand was an authorized dredging area approximately 6 to 12 miles offshore of Presque Isle.

(3) Converted from estimated tonnage using a unit weight estimate of 1.5 tons per cubic yard. Material obtained from an onshore source.

Note: One cubic yard is equivalent to 0.765 cubic meters.

Source: U.S. Army Corps of Engineers estimates.



Source: U.S. Army Corps of Engineers.

FIGURE 2–75 INSTALLATION OF PARTIAL BREAKWATERS IN THE PROPOSED LAKEFRONT PLANT PROJECT AREA

Recession Rates

2.536
The recession rates along the southeastern shore of Lake Erie in the vicinity of the proposed lakefront plant site are highly variable, both spatially and temporally. The differing rates of shoreline recession experienced at various points are typically due to the influence of manmade beach protection and harbor facilities. Variations in shoreline recession rates over time are principally due to the long-term lake level fluctuations and the random occurrence of severe storms and associated wind set-ups (short-term lake level fluctuations). In Ashtabula County, between Ashtabula Harbor and Conneaut Harbor, the shoreline is receding at a rate ranging from five feet per year to more than 10 feet per year. (2-140) This reach of shoreline line is starved of beach-building sediments, principally because the breakwater facilities of Ashtabula Harbor intercept the sediments present in the longshore currents. (2-141) At least 80 percent of the material eroded from the bluffs is typically too fine grained to be contributory to beach building. One estimate is that approximately 180,392 cubic yards per year of silt and clay are lost from the Ashtabula County shoreline to the deeper more quiescent depositional areas of Lake Erie. (2-136) Additionally, an estimated 52,288 cubic yards of potential beach material (gravel and sand) enters the nearshore region annually as a result of bluff erosion in Ashtabula County.

2.537
An accretional environment exists immediately to the west of the breakwater structures at Conneaut. A large beach, developed as the west breakwater intercepts the coarse sediment in the littoral drift, is advancing out from shore along the breakwater at a rate of 20 feet per year or more. The rate of accretion at this beach is progressively less westward and at the west end of Conneaut County Park, the accretion rate is approximately five feet per year. (2-140) However, severe erosion is occurring in the vicinity of the proposed project site just east of Conneaut Harbor. The east breakwater shorearm reflects waves approaching from the northeast, thus increasing wave energy at the shore. Recession rates as high as seven feet per year are occurring over a 670-feet stretch of shoreline. Along the Ohio shoreline farther to the east, recession rates are very much lower.

2.538
In Erie County, west of the state border, reported recession rates range from 4 inches to 24 inches per year with a county-wide average of one foot per year. The shoreline along Raccoon Creek County Park, immediately east of the site has undergone severe beach erosion (as great as 20 to 30 feet in eight months) in recent years. The County Park lies in the Raccoon Creek flood plain and is protected only by a

low (approximately (three feet) bluff. In general the western half of the county experiences more rapid shoreline recession than the eastern portion (1.24 feet per year versus .78 foot per year). The reduced shoreline recession rates in the eastern portion of Erie County are principally due to the following factors:

- Presque Isle, although a natural feature, serves as a large shore protection structure that shields much of eastern Erie County from the impacts of western and northwestern storms (directions of highest wave energy as shown in Figure 2-72).

- The more resistant shale bedrock is typically exposed at the base of the bluffs above the water line only in the eastern portion of Erie County.

In total, an average of nearly 248,000 cubic yards of sand and gravel and 77,100 cubic yards of silt and clay have been eroded from the Pennsylvania shoreline (excluding Presque Isle) annually during the period from 1870 to 1970. (2-136) Presque Isle itself has undergone considerable erosion since 1875 despite the efforts made to protect its beaches. In unprotected areas along Presque Isle, recession has averaged 537 cubic feet per foot in the period 1956 to 1970. In areas where groins have been constructed to stabilize the beaches, the rate of recession has averaged 40 cubic feet per foot of shoreline during the same period.

Longshore Transport Rates

2.539
There are very few estimates of longshore transport rates (i.e., rate of transport of sedimentary material parallel to the shore, usually expressed in cubic yards per year) along the shoreline between Ashtabula and Erie. Theoretical estimates based on an analysis of wave climate are not applicable to this shoreline since, in most areas, actual rates are limited by the availability of beach material. Estimates that are available are presented in Table 2-307. Longshore transport rates along Presque Isle are probably considerably higher than transport rates elsewhere due to the greater availability of beach sediment. Some of the values given in Table 2-307 are probably low; those values based on accretion rates neglect any sediment that might be transported past Presque Isle and therefore underestimate transport. A maximum rate at which beach building sediment is supplied to the western end of Presque Isle is given by the rate at which littoral material is eroded from the bluffs between Presque Isle and Conneaut Harbor (40,500 yds/yr) since the Conneaut Harbor is an effective barrier to littoral transport. The fact that this rate is so much lower than the transport rate on the isle itself

Table 2-307

Estimates of Longshore Transport Rates

Rate (m^3/hr)	Location	How Determined
96,000[1]	Presque Isle	Accretion (rate of growth of Eastern end) on Presque Isle over the past 300 years
106,000[1]	Presque Isle	Accretion (net gain) on Presque Isle from 1866-1947
31,000[2]	West of Presque Isle	Rate at which littoral material is eroded from bluffs between Presque Isle and Conneaut Harbor (since 1912)
6,000-14,000[3]	West of Conneaut Harbor	Approximate Rate of accretion of littoral material west of Conneaut Harbor
14,000[4]	West of Presque Isle	Rate of accretion between the Kelso Groin and Groin A between 1944 and 1947 (out to the 18 foot depth)
215,000[1]	Presque Isle	The average rate of material loss inside the 12 foot depth as calculated from survey profiles for the 1956-1958 time period

Source: (1) U.S. Army Corps of Engineers. Review Report on Cooperative Beach Erosion Control Project at Presque Isle, Peninsula, Erie, Pennsylvania, Buffalo, New York: U.S. Army Engineers District, September, 1975.

(2) Carter, C.H. Sediment Load Measurements Along the U.S. Shore of Lake Erie; and Arthur D. Little, Inc.

(3) Arthur D. Little, Inc.

(4) U.S. Army Corps of Engineers. Cooperative Beach Erosion Project at Presque Isle Peninsula, Erie, Pennsylvania. Final Environmental Impact Statement. Buffalo, New York: U.S. Army Engineers District, September, 1975.

explains the natural eastward movement of the landform. Longshore transport rates estimated from accretion rates behind large structures tend to be low for the following two reasons:

- Such structures may become "full" and beach material will then go around the structure or be channelled into deeper water;

- Generally, only the obvious accretion immediately updrift of the structure can be accounted for. Small changes in bottom topography encompassing large areas will usually go undetected, yet might indicate considerable accretion.

g) Fastland Erosion

2.540
The coastal areas within the regional study area are relatively flat except for the shoreline bluffs and erosional ravines created by the major streams. As such, significant soil erosion is likely to occur from these bluff faces, but is less probable in the other areas. The steeply-sloped valley walls associated with the incised streams are predominantly forested, providing a significant retardant to upland erosion on those slopes. Most of the agricultural and open lands are located in flatter areas where erosion is typically less severe. The erodibility of the soils of the region is highly variable. The strand deposits, due to their relatively coarse texture, typically have a low-to-medium potential for erosion. The silty lacustrine materials are the most readily eroded of the soils of the region because of their high content of finegrained materials. The overconsolidated silt-rich glacial tills have a medium erosion potential due to their very compact nature.

2.541
The highest erosion rates in the Regional Study Area occur in areas where vegetation has been removed for development. In these areas, erosion control measures are necessary to protect property and water quality. However, soil and climate conditions in the area tend to support vegetative growth. Thus, except during periods of severe climatic conditions, the relatively rapid recurrence of natural vegetation helps to ameliorate erosion conditions in disturbed uncontrolled areas. The Regional Study Area is subjected to a moderate number of high-intensity short-duration summer rainstorms that could account for the majority of the soil loss from upland areas. Additionally, the area can be subjected to several freeze-thaw cycles annually. This repeated freezing and thawing of the soil tends to increase the bulk of the silt-rich materials (particularly the lacustrine deposits), loosen it and render it more susceptible to erosion.

2.542
Numerical estimates of erosion rates in the Principal Study Area have been made, based on runoff data obtained at Turkey Creek. An average annual erosion rate of 1.2 tons/acre-year in the Turkey Creek drainage basin as calculated using a suspended solids concentration of 250 mg/l found in stormwater flows of Turkey Creek, assuming an average annual precipitation of 35 inches, and using a runoff coefficient and sediment delivery ratio for the portion of the Turkey Creek drainage basin upstream of sampling station TC-4 (in the vicinity of Rudd Road and the Conrail tracks) 0.3 and 0.25, respectively.

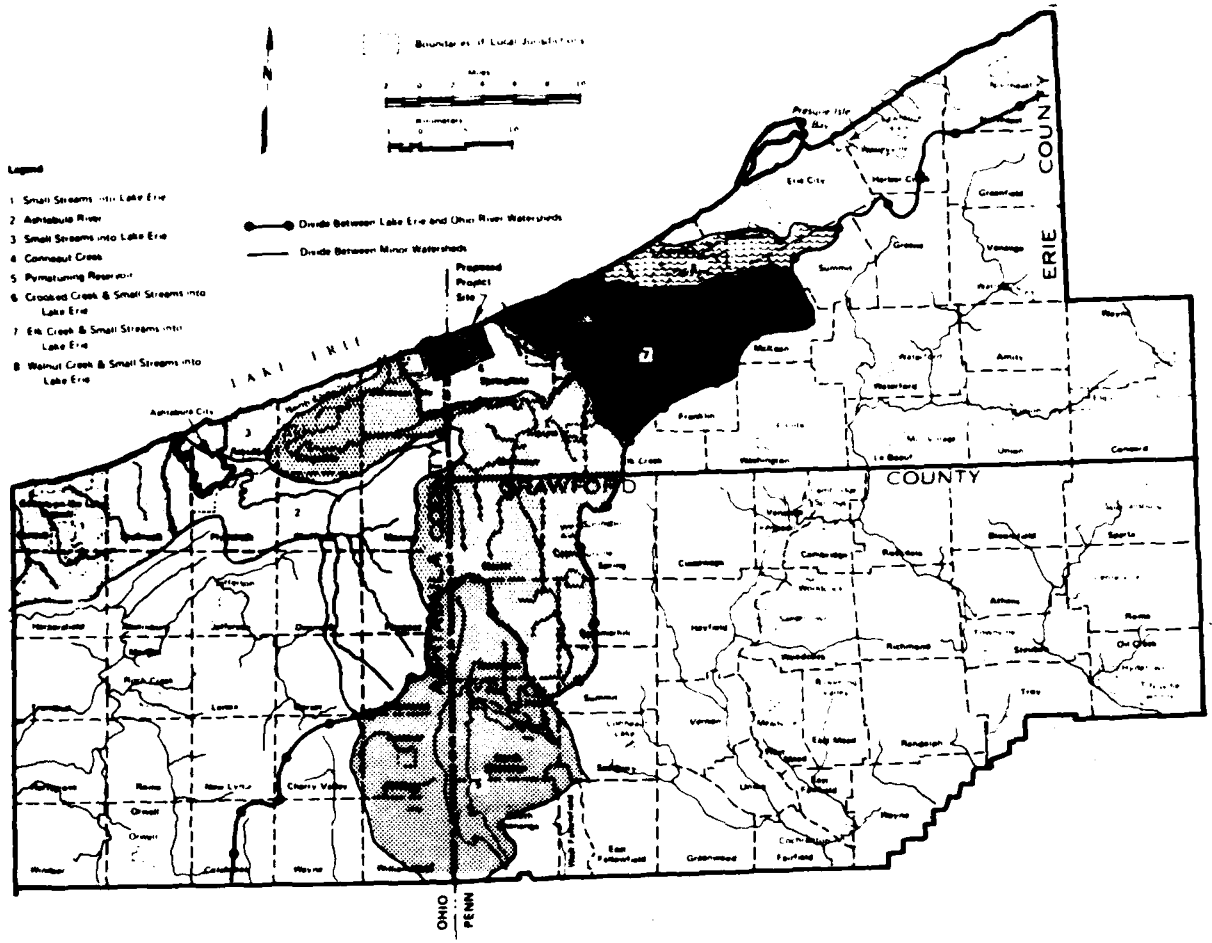
This calculation is shown below:

$$\frac{750 \text{ mg}}{\text{liter}} \times \frac{36 \text{ inches}}{\text{year}} \times \frac{0.3}{0.25} \times (1.13\text{x}10^{-4}) \frac{\text{tons-liter}}{\text{mg-acre-inches}} = \frac{1.35 \text{ tons}}{\text{acre-year}}$$

The methodology for determining erosion rates is very approximate, neglecting such phenomenon as streambank erosion and incorporating poorly known factors such as the runoff coefficient and the sediment delivery ratio. Based on this estimated average annual erosion rate of 1.35 tons per acre, numerical estimates of erosion rates in the Principal Study Area were made. An individual analysis was conducted for each of the eight drainage basins shown in Figure 2-76. The results are presented in Table 2-308. In conducting the analysis, only nonurban land usage was considered. Nonurban lands include agricultural areas, State game lands, open space, recreational tracks, wooded areas and rural residential acreage, and constitute over 95 percent of the land in the eight drainage basins studied. In actuality erosion rates within this land use sector will vary greatly. However, due to lack of better available information, the average value of 1.2 tons per acre per year was applied uniformly. This value is within the range of values reported by the county soil conservationists in Erie and Ashtabula Counties and by the USEPA in the report, Methods for Identifying and Evaluating the Nature and Extent of Non-Point Sources of Pollutants.

Site Geology

2.543
To define pertinent site-specific geologic, engineering, and chemical properties of surficial and subsurface materials, field and laboratory investigations were conducted by D'Appolonia Consulting Engineers, Inc., and Haley & Aldrich, Inc. The integrated field programs included photointerpretation, test borings, seismic refraction surveying, geologic and soils mapping, and confirmatory test pitting. Samples of soil and rock collected during the field investigations were returned to the laboratory for testing. Test for engineering properties and chemical characteristics pertinent to



Source: Arthur D. Little, Inc.

FIGURE 2–76 DRAINAGE BASINS IN THE REGIONAL STUDY AREA

Table 2-308

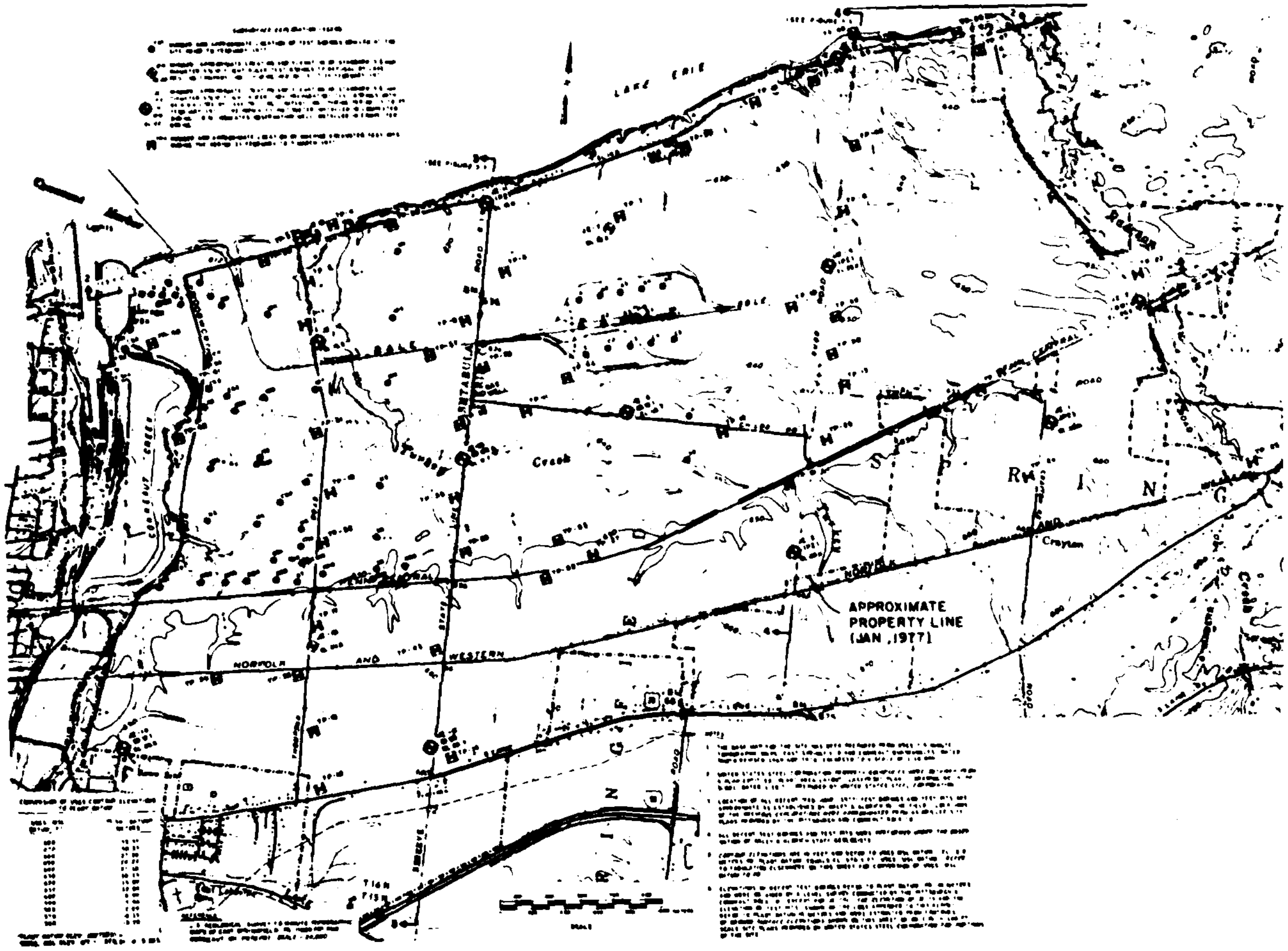
Erosion from Non-Urban Lands

Drainage Basin	Estimated Current Erosion (Tons/Year)[1]
1. Small Streams-Lake Erie	45,000
2. Ashtabula River	100,000
3. Small Streams-Lake Erie	10,000
4. Conneaut Creek	155,000
5. Pymatuning Reservoir	100,000
6. Crooked Creek and Small Streams-Lake Erie	30,000
7. Elk Creek and Small Streams-Lake Erie	80,000
8. Walnut Creek and Small Streams-Lake Erie	30,000

(1) Calculated assuming an erosion rate of 1.2 tons per acre per year for land undergoing rural use. Erosion from urban lands is not included.

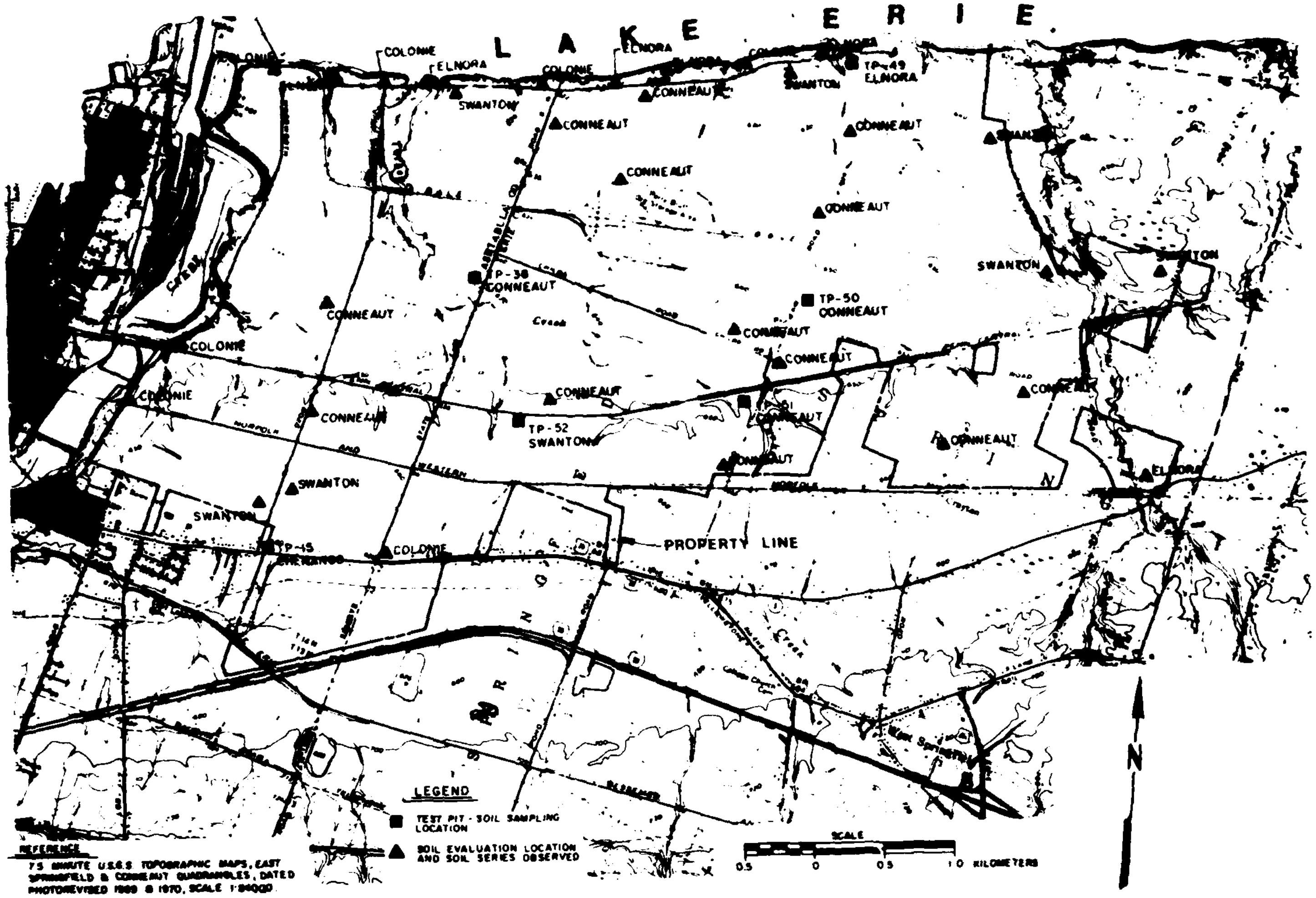
vegetative growth were conducted. Stereographic aerial photographic coverage was made available by U.S. Steel and consisted of two sets of panchromatic imagery at scales of 1:5,000 and 1:10,000. The site and near environs were photogeologically mapped on an ozalid blue-line map with a mirror stereoscope. Units were identified as to probable physical character (content of clay, sand, and gravel), mode of origin, and their relative position in the site stratigraphic column. To evaluate the nature, thickness and depth of various soils and rock strata at the site, the results of 74 test borings drilled within the site area prior to January 1977 were reviewed and evaluated. The test boring logs and as-drilled locations of previous test borings (drilled between 1969 and 1976) were provided by the Pittsburgh & Conneaut Dock Company, who manage and operate existing material storage, handling and stockpile facilities in the northwest quadrant of the site between Thompson Road and Conneaut Creek north of the Penn Central Railroad. The approximate locations of the previous exploration borings are shown in Figure 2-77.

2.544
In conjunction with the geological and geotechnical engineering studies reported herein, a test-boring program was conducted at the site, consisting of 15 test borings (JE-1 to JE-15) drilled from 15 to 25, February 1977, whose locations are also shown in Figure 2-77. The purpose of the exploration program was to define subsurface soil and rock conditions at areas not previously investigated, obtain representative samples of various soil and rock units for visual identification and laboratory testing, and install observation wells and piezometers at representative locations. A total of six observation wells and four piezometers were installed in completed boreholes to monitor water levels at the site. In addition, 53 test pits (TP-1 to TP-53) were excavated throughout the site area. The purpose of the test pits was to determine the nature of subsurface soil or rock conditions at shallow depths (typically three meters (10 feet) or less) below ground surface. They were used to confirm and supplement surficial geologic conditions interpreted from aerial photographs of the site, observe groundwater conditions in open excavations, and classify soils from an engineering viewpoint. The locations of the bore holes and test pits are shown in Figure 2-77. In March 1977, a field program was conducted to document published soils information and to obtain samples of representative soils for laboratory characterization of agronomic soil characteristics. Soils were examined at 32 locations throughout the site to identify the soil series present at each location and to note variability in important agronomic characters. Six test pits were excavated for the detailed evaluation and sampling of soils developed over the major geologic materials on the site. Representative bag samples were obtained from select sampling locations for testing. A map showing the location of soil sampling areas is presented in Figure 2-78. In conjunction with the



Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–77 SUBSURFACE EXPLORATION PLAN FOR THE PROPOSED LAKEFRONT PLANT PROJECT



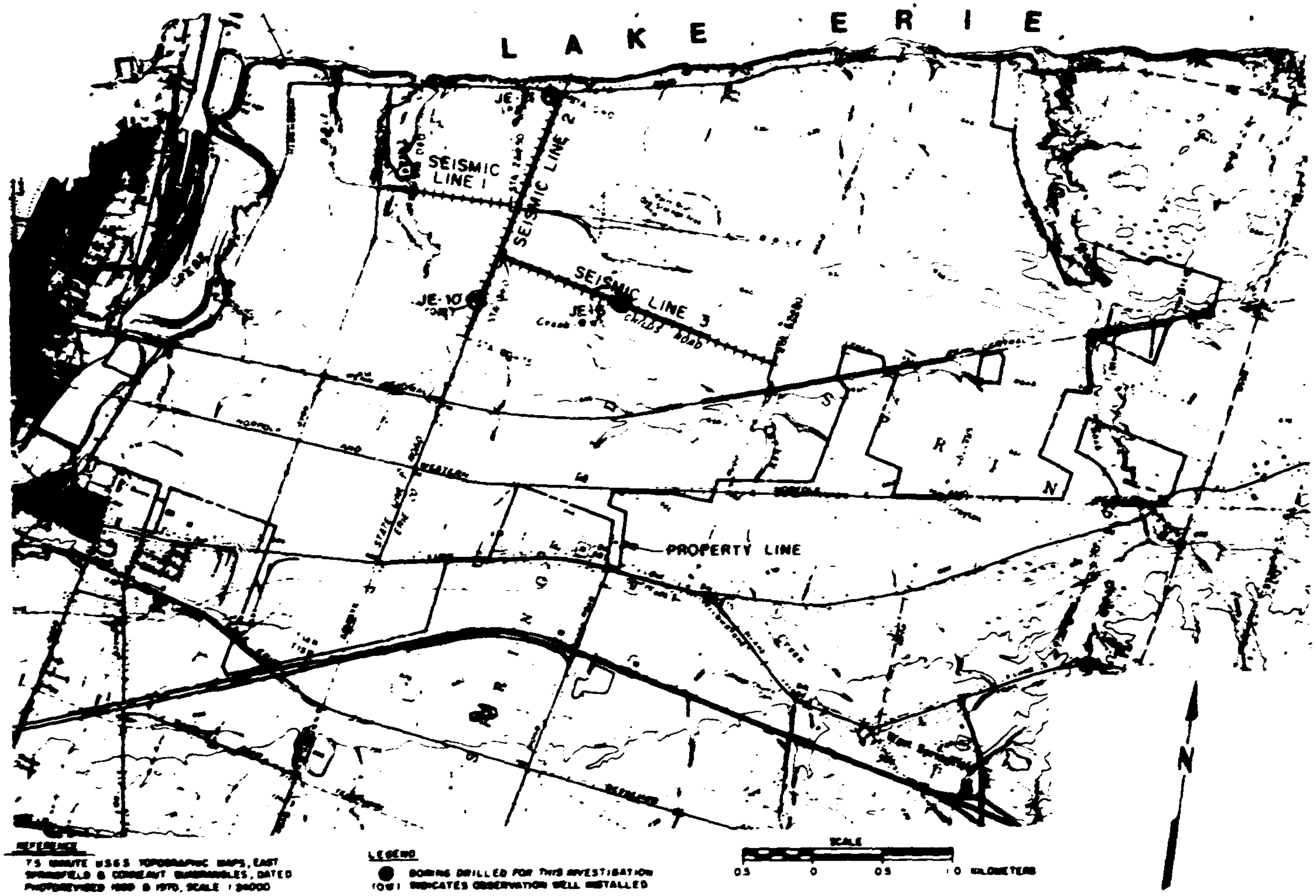
Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–78 PLAN OF SOIL SAMPLING AND SOIL EVALUATION LOCATIONS FOR THE PROPOSED LAKEFRONT PLANT PROJECT

test pit and boring programs, a seismic refraction survey was conducted to supplement the surficial geologic information and provide subsurface data between existing borings. The main purpose of the refraction survey was to delineate the bedrock surface underlying the 12 to 18 meters (40 to 60 feet) of overburden and to define anomalies in the rock surface if they exist. The refraction survey was performed during March 1977. As shown in Figure 2-79, data were obtained along three seismic lines totaling approximately 5,490 meters (18,000 feet). Petrographic Analysis of the fine-grained Ohio Shale rocks was conducted microscopically to determine mineral content and other important geologic features. Five representative specimens of the shale were selected during an overall review of all cores retrieved from the site. Of the five specimens studied, three are of the siltstone variety of shale and two are of the clay-shale variety, representative of the finest grained materials encountered in the Ohio Shale at the site. The siltstone variety is more common; the finer clay-shale mainly forms interbeds in the coarser material.

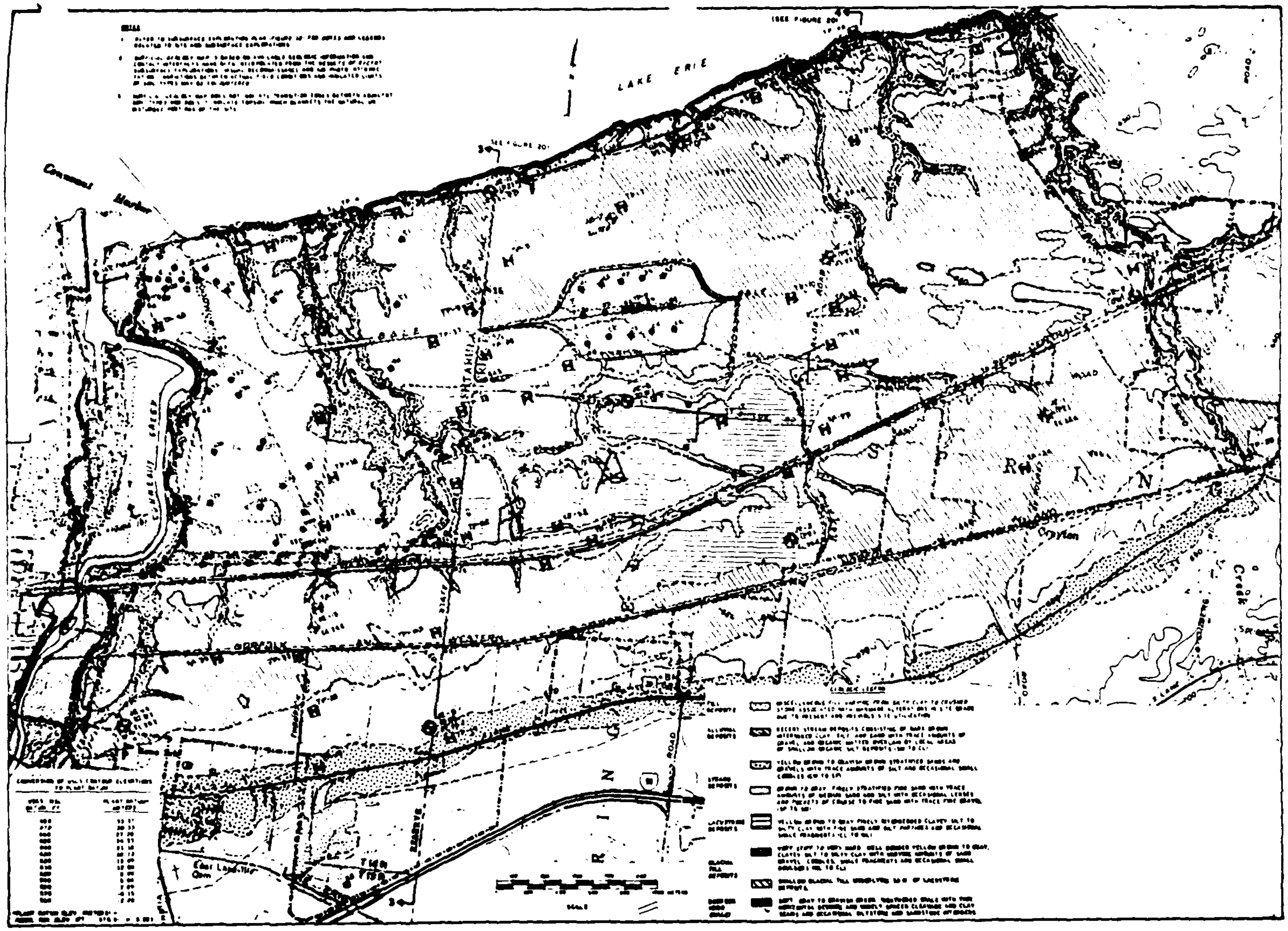
a) Subsurface Conditions

2.545
For the purposes of this discussion, soils are defined as those materials of Pleistocene or Recent age lying directly on the glaciated surface of the Chagrin Shale, the bedrock underlying the site. Soil units identified in this study have been subdivided on the basis of mineral composition, color, bedding characteristics, observed density or consistency and Standard Penetration Test (SPT) resistance. A map indicating the major surficial geologic features is shown in Figure 2-80. The local stratigraphic succession of the soil units, as well as the respective thickness of each unit, is depicted in the generalized subsurface profiles of Figures 2-81 and 2-82. The following sequence is typical of units identified during site investigations (the order is from youngest to oldest): fill material, alluvial deposits, strand deposits, lacustrine deposits, glacial till, glacio-lacustrine deposits, and bedrock. A soils map of the site prepared from soil survey reports for Erie County, Pennsylvania, and Ashtabula County, Ohio, published by the United States Department of Agriculture, Soil Conservation Service (SCS) is shown in Figure 2-83. Soils have been mapped by the SCS on the basis of parent material, depth to seasonal high water table, slope and other physical and chemical characteristics important to vegetative growth. The Ashtabula County soil survey is more recent (1973) than the Erie County survey (1960); hence, some of the soil series mapped in Erie County have since been revised. Site soils classified and mapped by the SCS on the subject site correlate well with the surficial geology of the site. Table 2-309 correlates the geologic units mapped on the site and the soil series developed from each of the geologic materials.



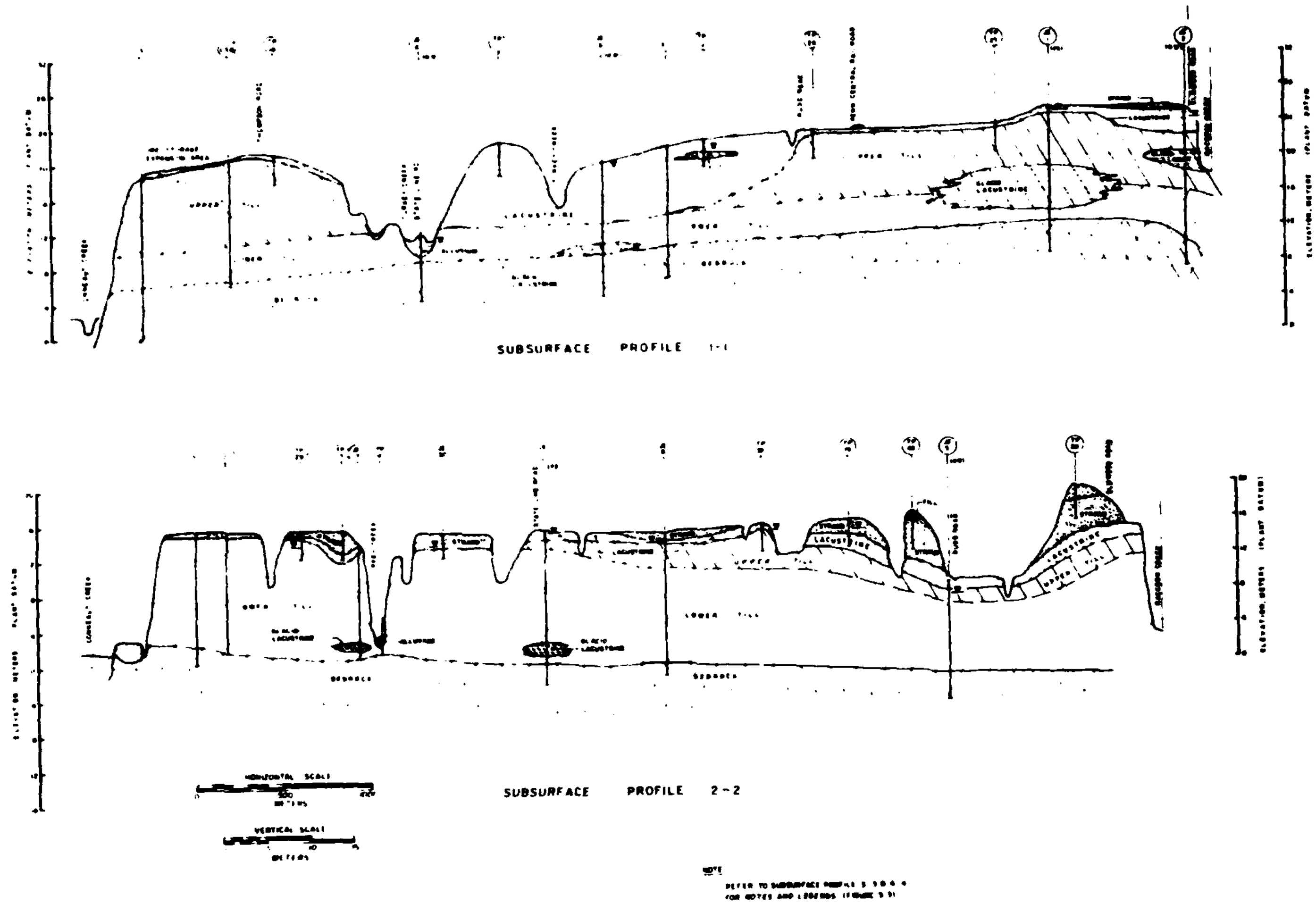
Source: D'Appolonia/Haley & Aldrich, Arthur D. Little, Inc.

FIGURE 2–79 LOCATION OF SEISMIC REFRACTION LINES FOR THE PROPOSED LAKEFRONT PLANT PROJECT



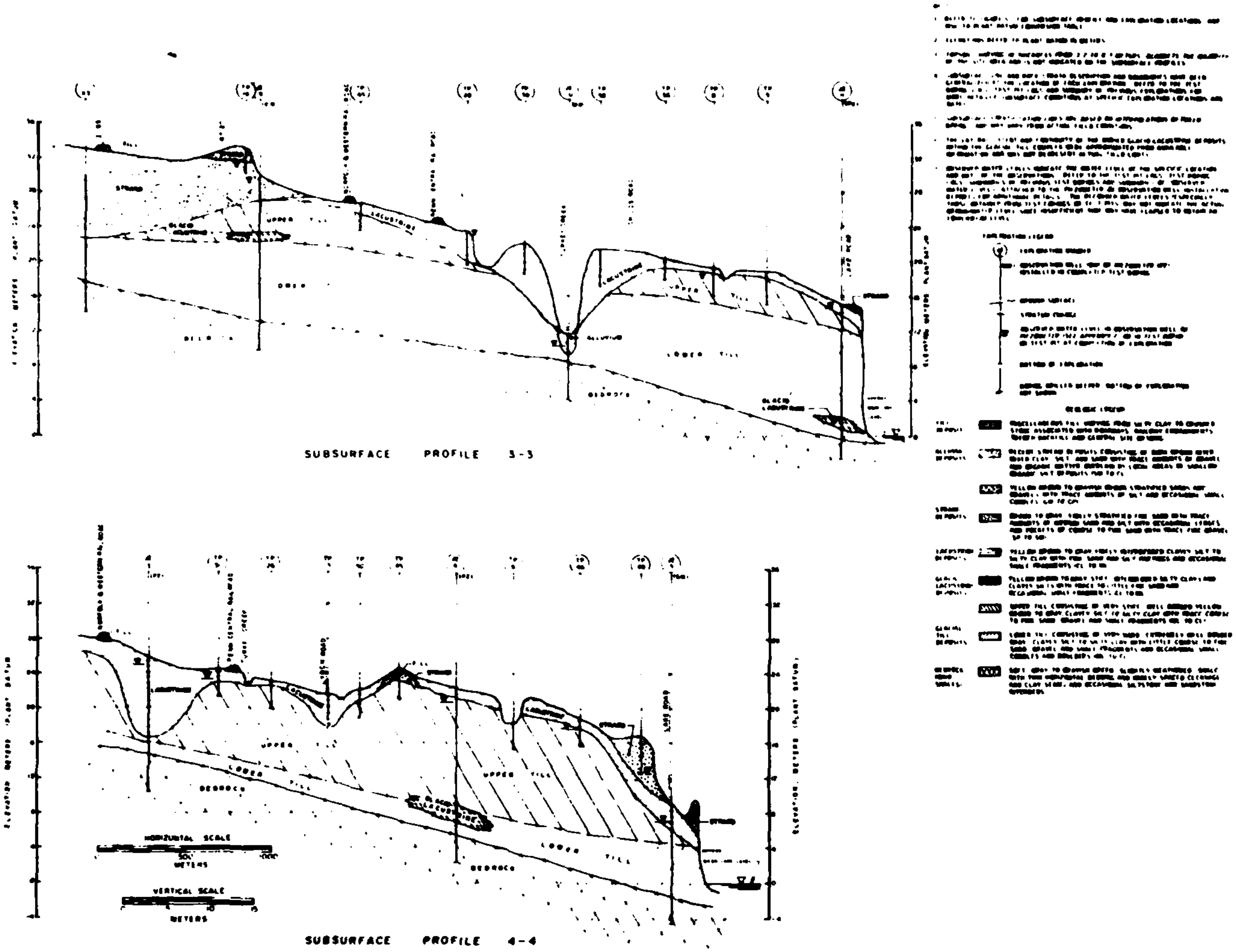
Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–80 SURFICIAL GEOLOGY MAP FOR THE PROPOSED LAKEFRONT PLANT PROJECT



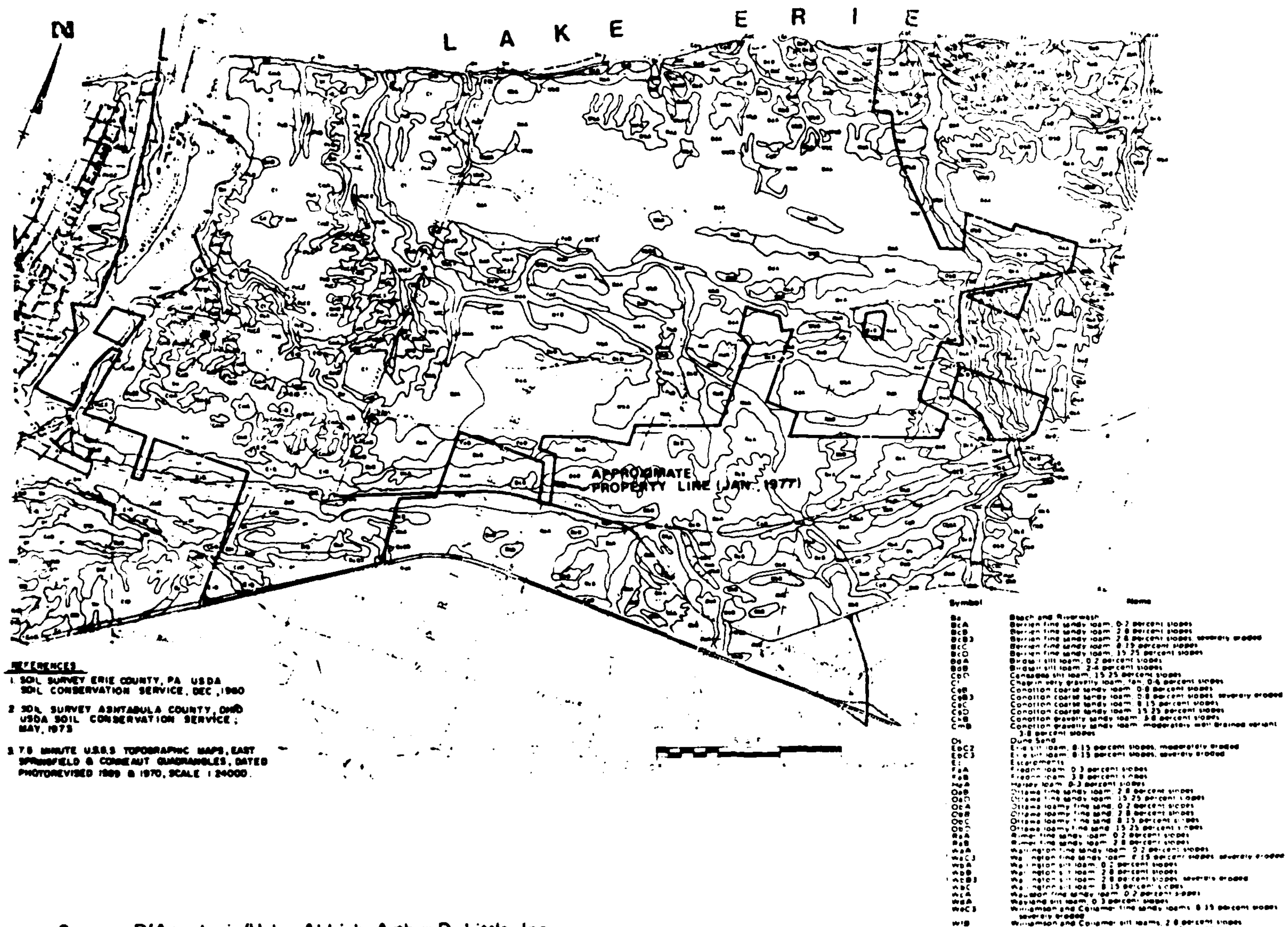
Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–81 SUBSURFACE PROFILE 1–1 and 2–2 FOR THE PROPOSED LAKEFRONT PLANT PROJECT



Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–82 SUBSURFACE PROFILE 3–3 and 4–4 FOR THE PROPOSED LAKEFRONT PLANT PROJECT



Source: D'Appolonia/Haley Aldrich; Arthur D. Little, Inc.

FIGURE 2–83 USDA–SCS SOIL MAP FOR THE PROPOSED LAKEFRONT PLANT PROJECT

Table 2-309

Relationship of Soils and Surficial Geology

Geologic Unit[1]	Soil Series[2][3]
Lacustrine deposits and thin lacustrine deposits over glacial till	Birdsall Caneadea Collamar Conneaut Wallington Williamson
Strand deposits-sand and gravel	Chenango Colonie Conotton Elnora Ottowa
Strand deposits-fine sand and silt	Berrien Claverack Kingsville Rimer Swanton Wauseon
Glacial till deposits	Erie Platea Pierpont
Alluvial deposits	Fredon Halsey Holly Lobdell Orrville Wayland

[1] Geologic units presented in Figure 2-80.

[2] Soil series presented in Figure 2-83.

[3]

Ashtabula County	Erie County
Claverack	Berrien
Chenango	Conotton
Colonie	Conotton
Conneaut	Birdsall
Elnora	Conotton
Holly	Wayland
Kingsville	Rimer
Orrville	Wayland
Swanton	Rimer

Source: D'Appolonia/Haley and Aldrich Joint Effort.

Fill Material

2.546
During previous site activity, appreciable quantities of fill were placed to bring facility areas to a desired grade to serve, for instance, as road and railroad beds or as iron ore storage areas. Such disturbed areas, together with those western segments of the site currently being graded, have been recorded on the surficial geology map, shown as Figure 2-80. The thickness of this fill material is typically less than 6.6 feet. Most of the fill material appears to be reworked lacustrine deposits with minor amounts of the originally underlying upper glacial till. This material is predominantly silty clay and sand. Coarser-grained granular fill, as well as processed material such as crushed and screened rock, are typically used for roadways, railway embankments and materials storage areas. These processed materials have normally been imported from offsite. The engineering and chemical properties of the fill vary with origin.

Alluvial Deposits

2.547
As streams and creeks on the site develop, they erode more rapidly through the strand and lacustrine deposits than through the underlying dense glacial till. Due to changes in velocity and sediment load, these streams have deposited a layer of alluvial soil in or adjacent to their courses. These alluvial materials are a mixture of the finer components of all units through which the individual stream has flowed in the past. The alluvial deposits typically consist of loose to medium dense, dark brown intermixed silty clay to clayey silt with variable amounts of sand and gravel overlain in some areas by shallow organic silt deposits.

Strand Deposits

2.548
Strand deposits are bodies of silty sand, sand, and sand and gravel that represent the shorelines of proglacial lakes. These ancient shorelines manifest themselves as continuous and semicontinuous ridges of low elevation, extending across the site area in east-west bands. The beach ridge underlying U.S. Route 20 and identified as representing the Lake Warren shoreline is generally less than 18 feet in height and consists of a sand and gravel core, exposed along the highway and flanked along the lake side by a band of stratified fine sand. In the central portions of the site area, two barely discernible strandlines are represented by isolated mounds of fine sand elongated in the east-west direction. The surface area covered by these isolated strandline sands is small, except in the vicinity of

the intersection of Elmwood Road and the Conrail right-of-way. Nearly all of the site shoreline bluff tops along Lake Erie are underlain by sandy silt and fine sand strand deposits generally less than 6.6 feet in thickness. In two test pits, more than 13.2 feet of strandline material were present. The strandline deposits consist of two general components as defined in the Surficial Geology Map (Figure 2-80) and the subsurface profiles (Figures 2-81 and 2-82). The coarse strand deposits are generally loose to medium compacted, yellow-brown to grayish brown, stratified sands and gravels with trace amounts of silt and occasionally small cobbles. The finer grained strand deposits consist of loose to dense, brown to gray, thinly stratified fine sands with trace amounts of medium sand and silt with occasional lenses and pockets of fine sand with traces of fine gravel. A large part of the site covered by strand deposits has developed soils in the Swanton, Elnora, and Chenango series. The Swanton series consists of deep, poorly drained, nearly level soils developed in silty strand deposits underlain by glacial till. Texture of the upper portion of the Swanton soil profile typically is a sandy loam or loamy sand while the underlying till is a dense silt loam similar to the Conneaut soils, (refer to Figure 2-83). The Elnora series consists of deep, moderately well-drained, gently sloping soils developed in sandy strand deposits with textures typically being loamy sand to sandy loam. The Chenango series consists of deep, well-drained, gently sloping soils developed in gravelly and sand strand deposits with textures typically being loamy sand to gravelly loam. A comprehensive summary of chemical characteristics of soil series representative of the major geologic materials at the subject site is shown in Table 2-310.

Lacustrine Deposits

2.549
As the Pleistocene ice sheets receded to the north from the present southshore of Lake Erie into what is now Canada, proglacial lakes formed and provided a means for deposition of thinly interbedded clayey silt and silty clay (i.e., the gray sediment residue of the rock floor washed ahead of the melting glacier). Most of the site is underlain directly by 3.3 feet or more of these lacustrine materials. However, a large pocket, nearly 33 feet thick in some places, of clays and silt occurs in the central portion of the site. Although there is no distinct surface evidence of the presence of this body, it has been detected by borings. The minimal density contrast between lacustrine deposits and till (especially the upper till) preclude discrimination by seismic refraction profiling. The lacustrine deposits consist predominately of soft to very stiff, yellow-brown to gray, finely interbedded clayey silts to silty clays with fine sand and silt partings and occasional shale fragments. Soil development in the lacustrine deposits is typically within the

Table 2-310

Soil Chemistry Data

Test Pit Number	Soil Series	Horizon	Sample Depth (cm)	USDA Texture	Coarse Fragments (> 2mm)	pH(1)	Electrical Conductivity(1) (mmhos/cm at 25°C)	Extractable Cations(2) (meq/100g) Ca	Mg	Na	K
		A1	0-28	Gravelly Sandy Loam	45.4	5.95	0.09	5.20	1.08	0.05	0.18
		B2	28-58	Gravelly Loamy Sand	18.3	6.00	0.05	NA	NA	NA	NA
TP-15	Chenango	C1	58-132	Gravelly Loamy Sand	20.5	5.00	0.04	0.54	0.30	0.01	0.04
		C2	132-203	Loamy Fine Sand	0.0	5.20	0.03	NA	NA	NA	NA
		C3	203-279	Loamy Sand	0.0	5.80	0.06	1.10	0.21	0.01	0.05
		A1	0-10	Silt Loam	19.7	4.55	0.14	NA	NA	NA	NA
		B2	10-91	Silty Clay Loam	0.0	6.00	0.12	NA	NA	NA	NA
TP-38	Conneaut	C1	91-137	Silty Clay Loam	0.0	6.20	0.19	NA	NA	NA	NA
		C2	137-203	Silty Clay Loam	0.0	6.90	0.14	NA	NA	NA	NA
		C3	203-254	Silt Loam	0.0	7.50	0.62	NA	NA	NA	NA
		A1	0-23	Loam	0.0	4.65	0.16	2.72	0.47	0.04	0.60
		B2	23-102	Fine Sandy Loam	19.7	4.95	0.12	NA	NA	NA	NA
TP-49	Elnora	C1	102-178	Loamy Fine Sand	0.0	4.70	0.14	0.90	0.31	0.01	0.26
		C2	178-254	Loamy Fine Sand	0.0	4.65	0.23	NA	NA	NA	NA
		C3	254-381	Loamy Fine Sand	0.0	5.75	0.26	1.26	0.70	0.01	0.81
		A1	0-20	Silt Loam	0.0	4.50	0.10	2.94	0.69	0.06	0.17
		B2	20-76	Silty Clay Loam	0.0	6.10	0.12	NA	NA	NA	NA
TP-50	Conneaut	C1	76-127	Silty Clay Loam	0.0	6.50	0.15	6.70	2.63	0.09	0.06
		IIC2	127-203	Silt Loam	0.0	7.05	0.18	NA	NA	NA	NA
		IIC3	203-305	Silt Loam	10.0	7.35	0.73	18.6	1.03	0.04	0.16
		A1	0-15	Sandy Loam	16.0	4.25	0.31	NA	NA	NA	NA
		B2g	15-122	Silty Clay Loam	0.0	6.20	0.15	NA	NA	NA	NA
TP-51	Conneaut	C1	122-137	Silty Clay	0.0	7.55	0.21	NA	NA	NA	NA
		IIC2	137-203	Silt Loam	0.0	7.70	0.21	NA	NA	NA	NA
		IIC3	203-305	Silt Loam	17.6	7.50	0.68	NA	NA	NA	NA
		A1	0-15	Coarse Sandy Loam	0.0	4.25	0.29	0.80	0.19	0.10	0.19
		B2	15-76	Loamy Fine Sand	0.0	5.45	0.10	2.27	0.65	0.02	0.05
TP-52	Swanton	C1	76-178	Loamy Fine Sand	0.0	6.40	0.16	NA	NA	NA	NA
		IIC2	178-254	Silt Loam	0.0	7.50	0.62	19.0	0.77	0.03	0.14

(1) 1:1 soil:water paste

(2) NH_4OAc extractable

Source: D'Appolonia/Haley & Aldrich Joint Effort, Report Vol. 1, Feb. 1978

Table 2-310 (Continued)

Test Pit Number	Soil Series	Horizon	Exchangeable Acidity(3) (meq/100g)	Cation Exchange Capacity(4) (meq/100g)	NO_3-N(5) (ppm)	PO_4-P(6) (ppm)	DTPA Extractable Trace Elements ppm Cu	Fe	Mn	Zn	$CaCO_3$ Equivalent (% by Weight)
TP-15	Chenango	A1	7.2	13.7	1.6	220	4.50	58.5	1.55	1.98	NA
		B2	3.6	NA	NA	NA	2.43	19.6	0.93	0.93	NA
		C1	3.6	4.49	0.4	33.4	4.40	22.5	2.10	2.80	NA
		C2	2.4	NA	NA	NA	1.00	21.0	0.95	0.48	NA
		C3	1.2	[illegible]	0.9	20.6	102	29.0	2.20	19.4	NA
TP-38	Conneaut	A1	[illegible]	NA	NA	NA	NA	NA	NA	NA	NA
		B2	[illegible]	NA	NA	NA	2.45	8.40	3.18	0.78	NA
		C1	[illegible]	NA	NA	NA	2.50	8.50	2.13	0.73	NA
		C2	0.6	NA	NA	NA	3.93	4.65	1.40	0.98	3.6
		C3	0(7)	NA	NA	NA	4.48	35.8	7.00	1.23	9.4
TP-49	Elnora	A1	21.6	[illegible]	2.1	240	6.96	504	6.32	12.2	NA
		B2	[illegible]	NA	NA	NA	NA	NA	NA	NA	NA
		C1	8.4	9.88	0.7	48.0	3.03	77.5	3.10	7.83	NA
		C2	9.6	NA	NA	NA	NA	NA	NA	NA	NA
		C3	6.0	8.78	5.0	22.6	4.93	37.0	3.78	1.88	NA
TP-50	Conneaut	A1	22.8	26.7	0.9	8.8	3.35	515	21.2	3.65	NA
		B2	4.8	NA	NA	NA	NA	NA	NA	NA	NA
		C1	4.2	13.7	1.2	3.0	2.33	4.95	2.55	0.58	NA
		IIC2	0	NA	NA	NA	NA	NA	NA	NA	3.6
		IIC3	0	19.8	175	6.4	4.30	37.0	6.88	1.03	9.2
TP-51	Conneaut	A1	27.0	NA	NA	NA	NA	NA	NA	NA	NA
		B2g	5.4	NA	NA	NA	NA	NA	NA	NA	NA
		C1	0	NA	NA	NA	1.78	3.60	1.95	0.58	24.7
		IIC2	0	NA	NA	NA	NA	NA	NA	NA	8.7
		IIC3	0	NA	NA	NA	NA	NA	NA	NA	9.0
TP-52	Swanton	A1	26.4	27.7	1.1	8.2	4.73	601	2.43	5.92	NA
		B2	5.4	8.39	6.8	16.0	7.58	40.0	2.15	1.25	NA
		C1	3.6	NA	NA	NA	NA	NA	NA	NA	NA
		IIC2	0	19.9	70.0	2.8	5.95	32.5	7.38	1.45	9.8

(3) SMP Buffer.
(4) Calculated by summing extractable cation and exchangeable acidity values
(5) Distilled water extraction-Nitrate electrode.
(6) Bray No. 1 and Olsen Procedures.
(7) By definition (pH 7.00).

NA- not analyzed
For test pit locations, reference Figure 15.

Conneaut series which include the deep, poorly drained, nearly level soils. The texture of the upper portion of the Conneaut soil profile is typically silt loam.

Till

2.550
Previous glaciation over the site area has resulted in deposition of two tills, the upper and lower, lying one upon the other, typically with the absence of a distinct separating horizon. Uppermost exposures of the upper till, lying beneath topsoil and lacustrine materials, are sometimes thinly stratified, consisting of laminae of irregular thicknesses, resembling lacustrine silts and clays, but containing fine gravel and being appropriately stiffer than the lacustrine materials. This pseudostratified material may be an ablation till phenomenon or may have resulted from water-laid deposition of ice-rafted till. Since the mode of origin is not clear, these materials have been identified as till on the basis of the gravel and the relatively greater density than ordinarily found in the lacustrine silts and clays. The upper till material consists of stiff to very stiff, well-bonded, yellow-brown to gray, clayey silt to silty clay with trace amounts of coarse to fine sand, gravel and shale fragments. The lower till is quite similar in description consisting of very stiff to hard, extremely well-bonded, gray, clayey silt to silty clay with little coarse to fine sand, gravel and shale fragments and occasional small cobbles and boulders. Differentiation between the two tills is typically based on the following consideration: lower, more dense till contains a small amount of coarse to medium sand in a clayey matrix and contains fine gravel and shale fragments, has dense appearance and is resistant to gouging by knife or rock hammer, has prominent vertical relief jointing and greatly increased penetration resistance (STP) during borehole sampling (30 to 100 blows per foot versus four to 30 blows per foot for upper till); upper till by contrast, typically does not contain relief joints and has only a trace of coarse to medium sand, and very few gravel-sized fragments. In most bluff outcrops, the upward fading of the vertical relief joints can be quite diagnostic of the transition between lower and upper till. It is most probable that this vertical jointing is the result of relief of stresses held in very dense till. The till approaches a brittle material and is hence unable to dissipate such stress through other than brittle fracture. Such brittle fracturing occurs at or near the developing shoreline bluff as erosion removes the lateral natural restraint. This erosion develops a face of equal stress relief, hence the tendency for the more dense till to expand along a plane roughly parallel to the emerging bluff face.

Glacio-Lacustrine Deposits

2.551
Glacio-lacustrine deposits represent deposition in a glacially associated lake-type environment. In the case of isolated pockets of this material found in the subsurface at the site, it appears that most of the deposition occurred in small ponds supplied by sediment-charged glacial melt-water streams. Most of these deposits occur near the base of the lower till, to a lesser degree, they are found at what has been interpreted as the upper/lower till contact. Since none of these materials are clearly exposed directly at the ground surface, the unit is not depicted on the surficial geologic map. Glacio-lacustrine deposits at the site generally consist of yellow-brown to gray, stiff, interbedded silty clays and clayey silts with a trace to some fine sand and occasional shale fragments. The diagnostic feature is their high degree of bedding, a feature which is not ordinarily present in the glacial till at the site.

Total Soil Depths

2.552
In addition to information on soil depths (depth to shale bedrock) provided by borings at the site, a seismic refraction survey provided pertinent data. Field data recorded by the seismograph were analyzed using a modified digital computer program originally developed by the United States Bureau of Mines. Based on geophysical seismic refraction testing, there is a very distinct break between the velocity in the till and bedrock. A review of the data indicates that low velocity anomalies were not encountered in the bedrock strata. In addition, no anomalies were encountered in the surface of the bedrock; the only detected irregularities are associated with weathering of the rock surface. Bedrock in the site area is an argillaceous (clayey) to arenaceous (sandy) shale known variously as the "Chagrin Shale" or the "Chagrin Formation" of the Ohio Shale group. As encountered in test borings, the Chagrin Shale was nearly always weathered to some degree, producing a material that can be broken by hand. The rock has a tendency to split on planes parallel to bedding, even in unweathered occurrences. The majority of core taken from borings was siltstone or silty shale, with varying amounts of clayey shale. Sandy siltstone was noted only in the creekbank of outcrops at the west margin of the site. Past studies indicate that the Chagrin Shale in northeastern Ohio has a maximum observed thickness of about 1,200 feet and that the unit generally increases in silt and sand content toward the Pennsylvania border. In samples recovered from the site borings, the Chagrin Shale generally fits previous descriptions for exposures in northeastern Ohio and northwestern Pennsylvania, gray to bluish-gray, thinly laminated siltstone

and fine silty sandstone, with clay seams and closely spaced vertical joints, some of which are clay-filled. Site outcrops of the shale are limited mainly to the east bank of Conneaut Creek, in the vicinity of the present ore flaggy sandy siltstone, tending to litter the creekbanks with tabular blocks of rock that have naturally split along bedding plane cleavages and near-vertical joints. Geologic structure in the shale bedrock is quite subdued. Regional dips to the south are generally reported in the literature. Along Conneaut Creek, however, the shale dips less than five degrees toward the north. Broad folds of 100 meters (330 feet) or more in wave length and a few meters amplitude are probably common; one example is present along the east bank of Conneaut Creek near Woodworth Road. Planar rock fractures lying at orientations other than parallel to bedding are the result of previous natural stress fields in the region and are referred to as joints. Joints are pervasive in the Chagrin Shale, resulting in the extremely blocky nature of the rock in outcrop, as well as in the thin, tabular segments of samples returned from core drilling. Jointing in the Conneaut Creek outcrops is nearly vertical and generally discontinuous, so each joint plane is traceable about four to eight feet along the face of a given exposure.

Geologic Hazards

2.553
Geologic hazards associated with the south shore of Lake Erie are generally linked to the presence of hillsides or bluffs, to the extraction of minerals, to floodprone streams and creeks, and to earthquakes. Since the site is essentially flat and undissected by streams entering from outside the boundaries, major landslides, and floods are of little concern. Minerals are not now extracted at the site and the limited withdrawal of natural gas has not produced land subsidence. A review of regional seismotectonics, coupled with information regarding site geology, shows no special earthquake-related hazards not already present throughout the general site region. In fact, due to the widespread occurrence of dense, cohesive soils, even the potential for seismically induced liquefaction is negligible.

Economic Deposits

2.554
The potential for economic occurrences of mineral and petroleum resources at the site is low. Potentially available resources within each of the geologic units identified for the site are shown below:

- Strand Deposits - Other than those under the U.S. Route 20 strand ridge, available deposits are limited to sands (without gravel) and/or are of very limited thickness and areal extent.

- Organic Soils - The materials of organic nature encountered in the present investigation were of extremely limited areal extent and thickness, and were not found to be suitable for agricultural purposes.

- Clays - The vase bulk of the on-site soils overlying bedrock are clay-rich and would present vast amounts of illite, montmorillonite and random mixed-order clays. However, there is nothing unique about this occurrence as compared with the south shore tills and lacustrine deposits in the site region. Commercial processing for even such crude uses as bricks would require careful washing and screening. Ceramic or filter-grade clays are not known to occur at the site.

- Bedrock - The Ohio shale, as sampled in test borings and in outcrop, does not exhibit hardness, bedding thickness, and freedom from jointing to qualify in any way as dimension stone. Similarly, its chemical constituency and low resistance to abrasion does not suit the shale and interbedded sandstone for use as aggregate.

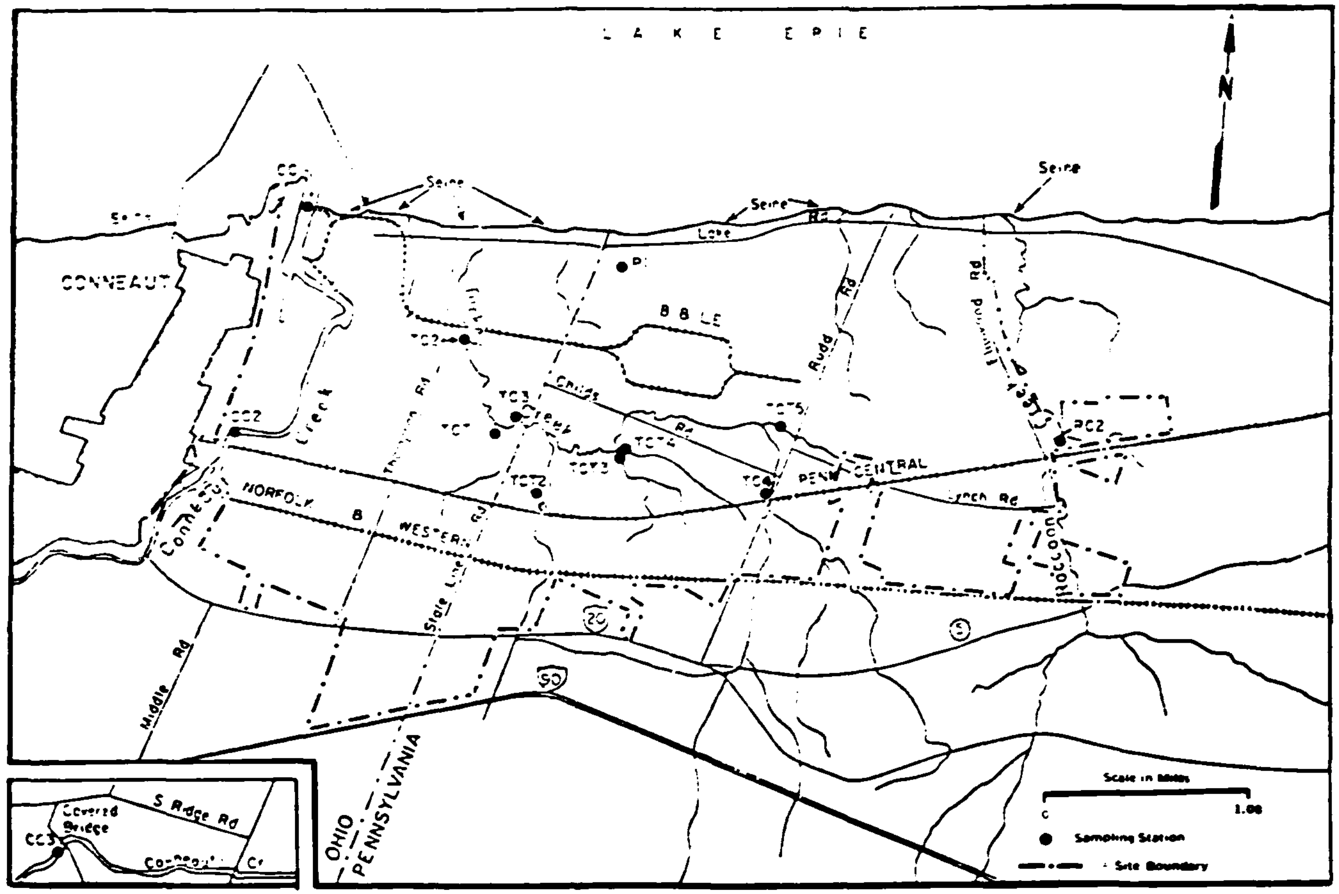
- Deeper Strata -- These geologic units are known to have produced limited amounts of natural gas in the past but all such wells are now abandoned. There is no indication of recoverable petroleum being associated with these small gas fields. As in other locations underlain by Silurian rocks, there is a potential for the existence of salt (halite) beds at depth. Salt as brine is not known to have been produced at the site and there is nothing unique about the site area from this standpoint.

d) Shoreline Erosion

Description of the Shoreline

2.555
The shoreline at the Project Site is dominated by steep, erodible bluffs, typically 10 meters or higher. The bluffline is broken by the drainage channels of streams originating from behind the coastal area and by gullies induced by agricultural tile drains, septic tanks, natural seepage outfalls, and other forms of drainage. Beach of varying width and topography runs along the foot of the bluffs.

2.556
The bluffs on the site are typical of those found along the entire stretch of shoreline between Ashtabula, Ohio and Presque Isle, Pennsylvania. Generally, bedrock shale at or near the water line is overlain with coarse-grained glacial till. Overlying the till is a



Source: Aquatic Ecology Association.

FIGURE 2–84 LOCATION MAP OF SEDIMENT SAMPLING STATIONS

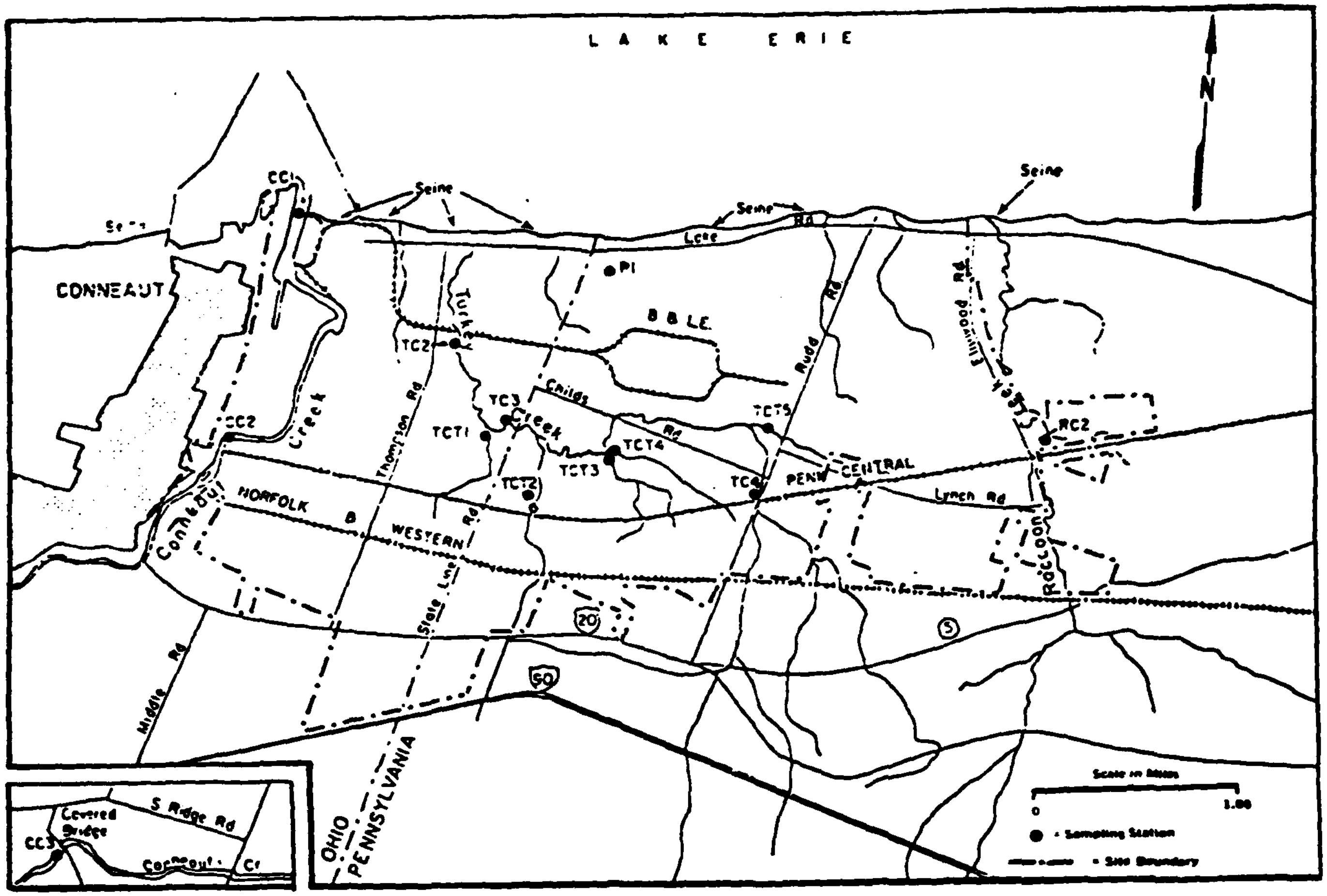
Table 2-311

Grain Size Analysis of Sediments
(Dry Weight Percentage)

Grain Size	Stations LE1	LE2	LE3	LE4	LE5	LE9	LE10
≥2.00mm	64.04	0.10	0.54	81.34	96.44	8.12	88.26
1.00mm	4.82	0.14	0.14	4.08	1.40	3.50	1.86
0.500mm	4.46	0.10	0.14	3.90	0.50	8.58	1.96
0.300mm	9.30	4.80	6.36	4.78	0.26	31.02	5.36
0.125mm	15.62	19.98	14.96	3.54	0.64	35.38	1.76
0.063mm	0.78	30.06	25.58	1.50	0.46	10.06	0.32
<0.063mm	0.98	44.82	52.28	0.86	0.30	3.34	0.48

(1) Sediments were collected from Lake Erie on July 7, 1977 and the two downstream sections in Conneaut Creek on July 8, 1977.

Source: Aquatic Ecology Associates.



Source: Aquatic Ecology Association.

FIGURE 2–84 LOCATION MAP OF SEDIMENT SAMPLING STATIONS

clay sequence and overlying the clay, sands of lacustrine origin. Subsurface Profile 2-2 (see Figure 2-81) indicates the detailed stratigraphy of the bluffs. This profile runs parallel to the shoreline at a distance of approximately 33 feet from the lake. At the shoreline, the elevation of the geological horizons may be five to 10 meters lower than as shown on Subsurface Profile 2-2 due to the northwards dip of the formations.

2.557
The beach along the site is tyically narrow (seven to 17 feet in width) and slopes approximately 15° to 20° to the water. As is true regionally, beach widths and slopes on the project site are highly dependent on the lake levels and wave climate. The beaches consist primarily of sand and gravel and may contain some slate or shale shingles. Material finer than the No. 140 sieve (0.106 millimeters) is not present in significant quantities, (2-138) although muddy deltas of finer grained sediment may sometimes be found at stream outlets (e.g., at Raccoon Creek). (2-142) Past studies indicate that the lake bottom consists of exposed shale at the 26-foot contour (2-143, 2-144). Recent investigations by Aquatic Ecology Associates in the lake area adjacent to the proposed site indicate that where bedrock is not exposed it is only covered by a layer of sediment two-six inches thick. Samples of this sediment were collected and analyzed to determine grain-size distribution (refer to Figure 2-84 and Table 2-311). Generally, the bottom sediment in the harbor is fine-grained, undoubtedly deposited by Conneaut Creek. The nearshore samples obtained outside the harbor, on the other hand, consisted primarily of coarse-grained sediment (derived most likely from eroded bluff material). Those samples taken farther offshore showed variable but generally bimodal grain-size distributions, reflecting a mixture of coarse and fine-grained material derived from the shoreline bluffs and some even finer material carried into the lake by Conneaut Creek.

Shoreline Processes

Bluff Erosion

2.558
Erosion of the site shoreline to the west of State Line Road is somewhat less than that encountered eastward toward Raccoon Creek with the exception of the area near the Conneaut Breakwater where erosion is severe. Presumably, the reduced rate of erosion east of State Line road is related to an increase in the elevation of the bedrock (refer to Profile 2-2, Figure 2-81). The normally severe erosion along the segment of shoreline between the State Line and Raccoon Creek has been exacerbated by high lake levels in recent years. The Pennsylvania DER reports, "The entire section can be

characterized by rapid recession ... high water levels have had devastating effects at the base of the slope producing a near vertical bluff ... recession has been greatly accelerated in the past five years ... fallen large blocks of material and slumping are readily evident." This report describes average recent recessional rates of 0.46-0.58 meters per year; however, in "a particularly critical point ... investigators witnessed four feet of recession from February to April 1975." (2-144) During field investigations early this spring 1977 bluffs were found to be very unstable. The continual seepage of groundwater through the face of the bluff (usually between the upper and lower till layers) was an obvious contributor to the erosional process and probably account for the mud flows of bluff material which extended 10 to 15 meters out over the lake ice.

Sediment Transport

2.559
Beach material is transported along the shore under the action of waves, and littoral transport is predominantly eastward in the vicinity of the project site. The net movement of material to the east is evidenced by the frequent formation of bars rooted at their westward end partially blocking the mouths of streams, such as Raccoon Creek. Sediment transport processes in the vicinity of Conneaut Harbor are complicated by the presence of the harbor breakwaters. On the one hand, the breakwaters tend to shelter the Ohio segment of the project site shoreline from wave action from the west, thus reducing eastward litteral transport. On the other hand, when waves from the north to northeast reach the east breakwater, they are reflected and will break at the shore as if they had originated from the west. The presence of any beaches at all along this stretch of shoreline indicates that westward transport does take place, at least some of the time. (The Conneaut Harbor breakwaters act as barriers to the littoral transport of beach material (2-133) and thus the sand and gravel comprising the beaches on the project site has its origin either on the site itself or to the east). However, the absence of a large wedge of beach against the eastern side of the east breakwater indicates that westward transport processes cannot be strongly dominant. Onshore-offshore transport processes are of limited importance due to the dearth of nearshore sediments. The process seems to be one-way only, as predominantly fine-grained alluvial or bluff derived material is transported out into the lake.

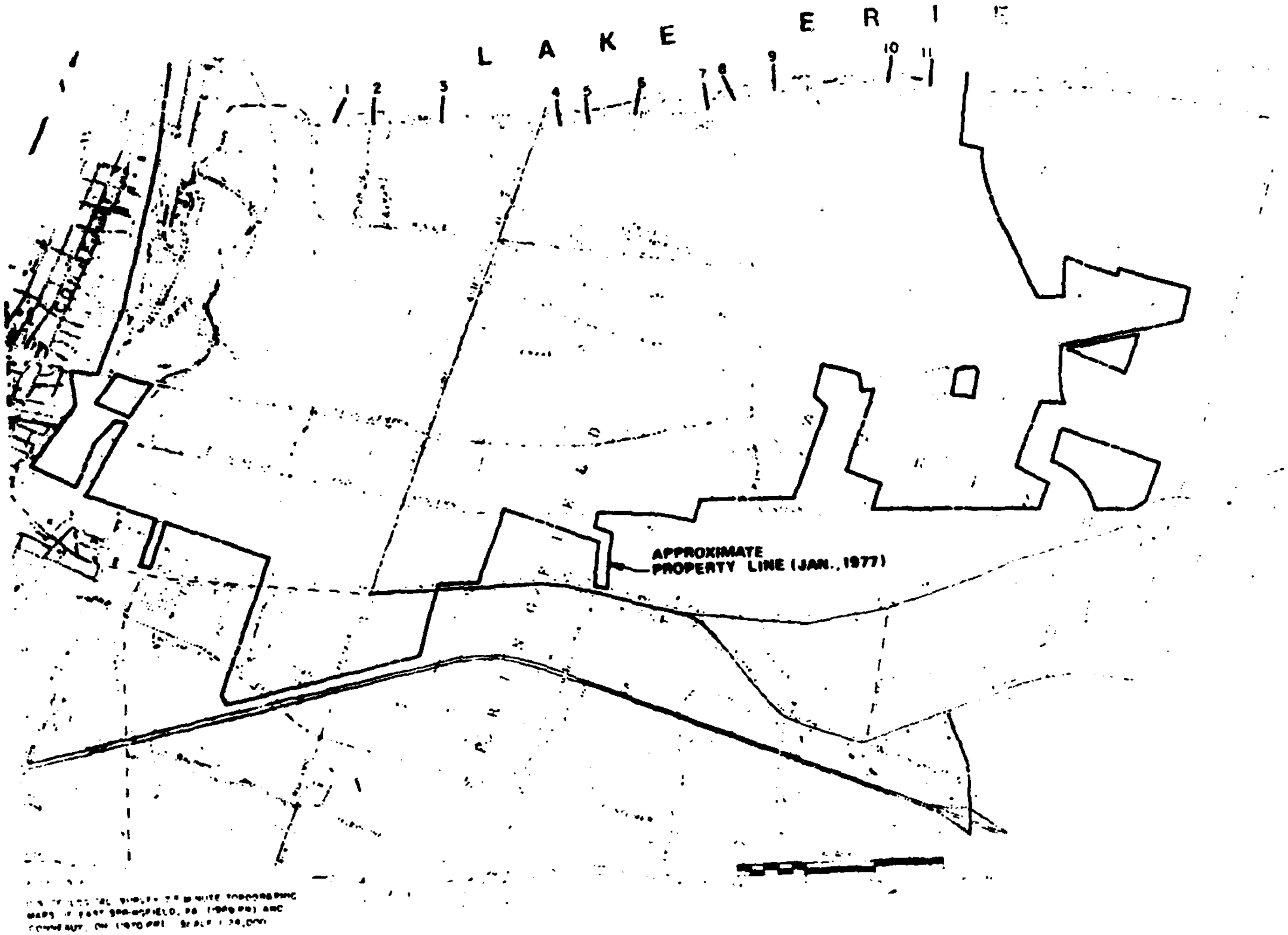
Recession Rates

2.560
Recession rates of the shoreline bluff were determined through an analysis of aerial photographs, topographic maps, and hydrographic

survey charts dating back to 1866. (2-111) The control sections used in the analysis are shown in Figure 2-85, and the measured recession rates along each control section are presented in Table 2-312. The measurements along the control sections at the site indicate that the shoreline is receding at a relatively slow rate. These measured recession rates are similar, in some cases, to those reported in the literature as indicated in Table 2-313. The shoreline bluffs along the western portion of the site with the exception of the area immediately east of the Conneaut Harbor breakwater, appear to be generally stable with no recession of the toe of the bluff in the past 110 years and a very slight recession of the top of the bluff averaging about feet per year (0.06 meters per year). The recession rate of the shoreline increases from west to east with the maximum recession occurring approximately 4,620 feet east of State Line Road. At this location, the recession rate measured to the top of the bluff averages 0.56 meters per year based on data collected over the past 38 years. The recession rate is nearly constant from this point to the eastern boundary of the site (refer to Figure 2-86). The reported recession rates indicate shoreline erosion can vary considerably and that substantial shoreline erosion can occur in a relatively short period of time, principally as a result of severe storms. There appears to be little correlation between the periodic recession rates measured to the tops and toes of the shoreline bluffs. This result reflects the dynamic mechanisms of the shoreline recession whereby oversteepening of the bluffs is cyclically followed by mass wasting.

Volume and Nature of Site Sediment Losses

2.561
The shoreline recession rates shown in Table 2-314 have been evaluated relative to the bluff relief and composition. With regard to the relief, a total annual volume of about 25,000 to 30,000 cubic meters of material is removed from the proposed site. On a unit basis, this total represents an annual loss of approximately five cubic meters per year per meter of shoreline length. One study in Erie County, computed unit recession rates of 3.8 cubic meters per year per meter of shoreline. (2-136) The difference in these rates is understandable when considering the lengths of shoreline involved and the location of the project site in the western part of Erie County. Evaluation of the grain-size information for the various units indicates that only about 20 percent to 25 percent of the material eroded from the project site is suitable for beach nourishment. The remainder probably is removed from the littoral drift and deposited in deep water. Volumetrically, the site contributes about 5,000 to 10,000 cubic meters per year of potential beach material to the downdrift areas to the east.



Source: D'Appolonia/Haley & Aldrich; Arthur D. Little, Inc.

FIGURE 2–85 LOCATION OF CONTROL SECTIONS FOR MEASURING SHORELINE RECESSION OF THE PROPOSED LAKEFRONT PLANT PROJECT

Table 2-312

Summary of Measured Shoreline Recession Rates
(Meters/Year)

Measured Section(1)		1866-1901	1938-1950	1950-1959	1959-1968	1968-1972	1972-1976	1866-1976	1938-1976
1.	Top of Bluff	- (2)	-	-	-	-	-	-0.06(3)	-
	Toe of Bluff	+0.26	-	-	-	-	-	0.00	-
2.	Top of Bluff	-	-	-	-	-	-	-	-
	Toe of Bluff	-	-	-	-	-	-	-	-0.23
3.	Top of Bluff	-	-0.66	-0.10	-	-	-	-	-0.23
	Toe of Bluff	-	-0.94	+0.37	-	-	-	-	-0.47
4.	Top of Bluff	-	-0.18	-0.34	-0.30	0.00	-0.08	-	0.22
	Toe of Bluff	-	-0.33	+0.27	+0.41	-1.30	-0.46	-	-0.13
5.	Top of Bluff	-	-0.48	-0.13	0.00	0.00	-0.46	0	-0.23
	Toe of Bluff	-	-0.30	-0.10	-0.24	-0.61	-0.15	-	-0.26
6.	Top of Bluff	-	-0.05	-0.30	-0.37	0.00	0.00	-	-0.18
	Toe of Bluff	-	-0.63	-0.14	+0.58	-0.83	-1.83	-	-0.48
7.	Top of Bluff	-	-0.25	-0.54	-0.41	-	-	-	-0.39
	Toe of Bluff	-	-0.53	-0.85	+0.27	-	-	-	-0.29
8.	Top of Bluff	-	-0.41	-0.95	-0.75	-	-	-	-0.56
	Toe of Bluff	-	-0.97	-1.05	+0.03	-	-	-	-0.86
9.	Top of Bluff	-	-0.81	-0.54	-0.17	-	-	-	-0.51
	Toe of Bluff	-	-1.14	-0.54	-0.34	-	-	-	-0.88
10.	Top of Bluff	-	-0.56	-0.75	-	-	-	-	-0.51
	Toe of Bluff	-	-0.61	-0.85	+0.10	-	-	-	-0.65
11.	Top of Bluff	-	-0.28	-1.12	-0.34	-	-	-	-0.52
	Toe of Bluff	-	-0.36	-1.29	-0.44	-	-	-	-0.72

(1) For measured control section locations, see Figure 2-85.

(2) - Recession rate not calculable from available data.

(3) Minus sign (-) indicates erosion; plus sign (+) indicates accretion.

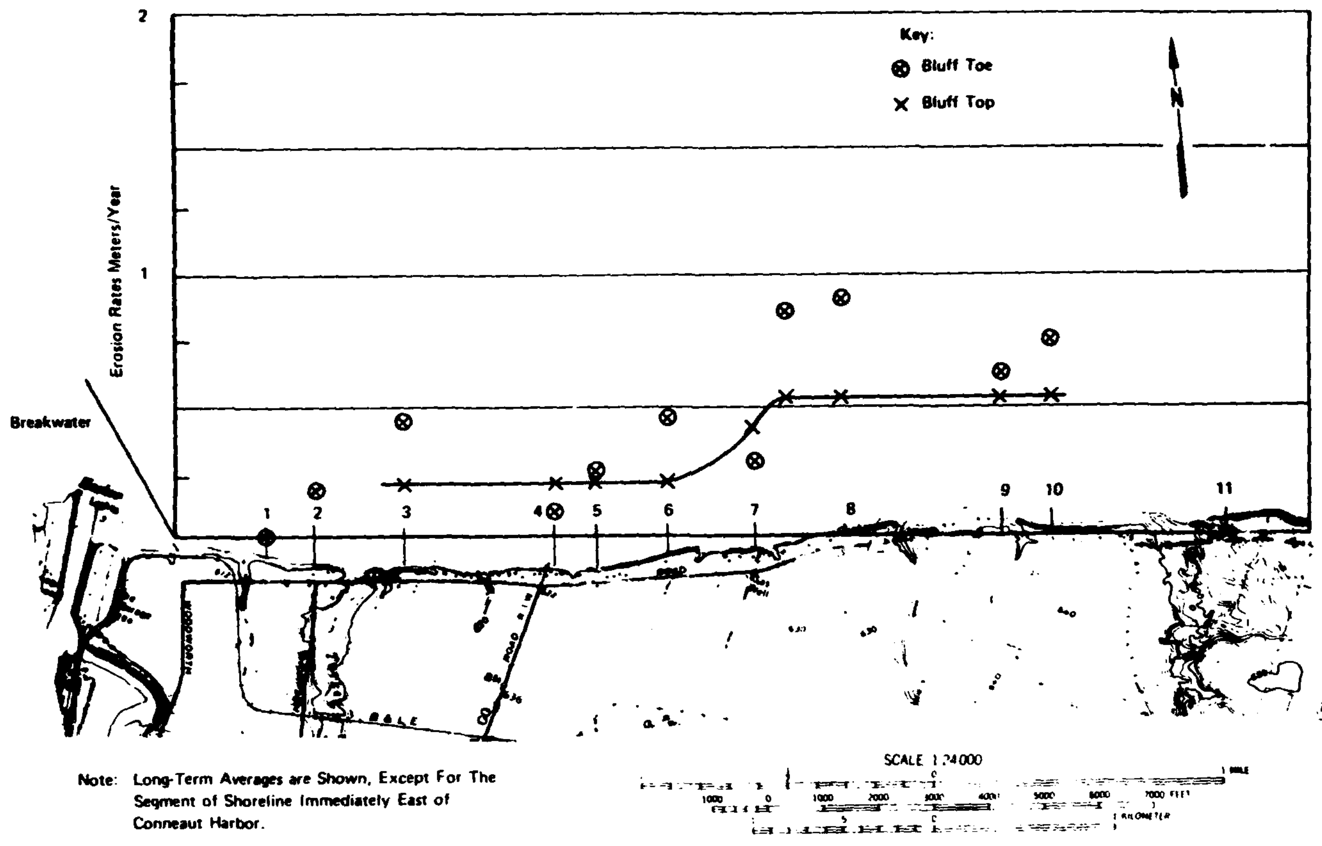
Source: D'Appolonia/Haley and Aldrich Joint Effort.

Table 2-313

Summary of Reported Shoreline Recession Rates

(Meters/Year)

Location	Period of Record	Reported Recession Rate	Reference
Ohio-Pennsylvania State Line East to Rudd Road (Erie County, PA)	1938-1974/ 1975	0.48	Knuth and Crowe, 1975
Vicinity of Ohio-Pennsylvania State Line (Erie County, PA)	Feb. 1975- Apr. 1975	7.32	
Rudd Road to Elm-wood Road (Erie County, PA)	1938-1974/ 1975	0.44	
Conneaut, Ohio to approximately 200' west of Ohio-Pennsylvania State Line (Ashtabula County, OH)	Not given	Stable	Ohio Department of Natural Resources, 1961
60 meters west to Ohio-Pennsylvania State Line (Ashtabula County, OH)	Not given	0.30±	
Vicinity of Ohio-Pennsylvania State Line (Erie County, PA)	Apr. 1975- Feb. 1977	1.88	Knuth, 1977



Note: Long-Term Averages are Shown, Except For The Segment of Shoreline Immediately East of Conneaut Harbor.

Source: Arthur D. Little, Inc.

FIGURE 2–86 RECESSION RATES ON THE PROPOSED LAKEFRONT PLANT SITE

Table 2-314

Local Climatological Data for Erie, Pennsylvania

Month	Temperatures °F: Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal Degree days Base 65°F: Heating	Cooling	Precipitation in inches: Water equivalent: Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs	Year	Snow, Ice pellets: Maximum monthly	Year	Maximum in 24 hrs	Year
(a)				23		23					23		23		21		22		22	
J	31.7	18.5	25.1	64	1967	-15	1963	1237	0	2.47	6.59	1959	0.90	1967	1.51	1959	29.9	1966	10.0	1958
F	32.5	17.9	25.2	67	1957	-12	1973	1114	0	2.12	5.01	1976	0.73	1969	2.16	1961	32.1	1972	12.4	1971
M	40.4	25.6	32.9	79	1967	-1	1960	995	0	2.75	4.78	1976	0.63	1960	1.07	1965	26.8	1971	12.0	1965
A	53.5	36.1	44.8	85	1958	12	1954	606	0	3.55	7.11	1961	1.43	1975	2.42	1961	17.2	1957	10.0	1957
M	63.7	45.5	54.6	89	1975	26	1970	336	13	3.63	5.59	1956	1.65	1962	2.23	1969	0.1	1963	0.2	1963
J	73.5	55.6	64.6	92	1964	32	1972	80	46	3.50	7.74	1957	0.85	1963	2.80	1957	0.0		0.0	
J	77.6	60.0	68.7	94	1968	44	1963	26	139	3.52	7.70	1970	1.11	1974	3.22	1970	0.0		0.0	
A	76.0	58.9	67.5	92	1965	41	1973	43	120	3.39	8.93	1975	0.58	1959	3.29	1975	0.0		0.0	
S	70.2	52.6	61.4	94	1959	33	1974	141	31	3.56	7.08	1970	1.65	1960	6.44	1958	0.0		0.0	
O	60.2	43.0	51.6	88	1963	24	1975	433	0	3.26	9.87	1954	1.13	1963	4.35	1954	4.0	1954	2.3	1974
N	44.5	33.7	40.1	80	1961	7	1976	747	0	3.70	5.91	1963	1.05	1956	2.86	1956	36.3	1967	23.0	1956
D	34.8	23.3	29.1	68	1966	-2	1976	1113	0	2.81	4.55	1975	1.38	1960	1.86	1968	56.0	1963	12.9	1966
Yr	55.0	39.2	47.1	94	Jul 1968	-15	Jan 1963	6851	373	38.20	9.87	Oct 1954	0.58	Aug 1959	6.44	Sep 1959	56.0	Dec 1963	23.0	Nov 1956

Month	Relative humidity pct.: Hour 01	Hour 07	Hour 13	Hour 19 (Local time)	Wind: Mean speed m.p.h.	Prevailing direction	Fastest mile: Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset
(a)	11	11	11	11	23	8	19	19			21
J	76	76	72	73	13.4	WSW	62	32	1950		8.5
F	75	77	70	74	12.5	WSW	52	29	1972		8.0
M	74	77	67	71	12.4	WSW	55	34	1960		7.5
A	72	75	61	67	11.8	WSW	46	27	1965		6.7
M	77	79	64	65	10.2	WSW	37	25	1964		6.6
J	80	81	64	66	9.6	S	37	36	1975		5.8
J	81	82	64	65	9.1	S	46	32	1959		5.5
A	84	86	66	70	9.1	S	35	24	1970		5.5
S	82	85	67	73	10.3	S	45	17	1965		6.2
O	76	78	65	74	11.4	SSE	39	21	1967		6.5
N	77	78	71	75	13.1	SSW	39	30	1968		8.4
D	77	78	74	76	13.6	SSW	30	17	1964		9.0
Yr	77	79	67	71	11.4	S	55	14	Nov 1960		7.0

Month	Mean number of days: Sunrise to Sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility 1/4 mile or less	Temperatures °F: Max.: 90° and above (b)	Max.: 32° and below	Min.: 32° and below	Min.: 0° and below	Average station pressure mb. Elev. 737 feet m.s.l.
(a)	21	21	21	23	23	21	21	11	11	11	11	4
J	2	4	25	18	7	*	1	0	15	28	3	991.3
F	2	6	20	15	5	1	2	0	14	26	2	989.9
M	4	8	19	15	3	1	3	0	8	24	*	988.5
A	6	8	16	14	1	3	2	0	1	13	0	989.2
M	6	11	14	12	0	4	2	0	0	1	0	987.1
J	8	11	11	10	0	6	1	*	0	*	0	988.9
J	9	13	9	10	0	6	*	*	0	0	0	989.4
A	10	10	11	11	0	7	*	*	0	0	0	992.1
S	7	9	14	10	0	4	*	0	0	0	0	991.6
O	7	8	16	12	*	3	*	0	0	3	0	992.7
N	2	5	23	16	3	2	1	0	2	13	0	989.7
D	1	4	26	19	7	*	1	0	11	26	*	990.3
Yr	64	97	204	161	26	38	14	1	52	134	6	990.1

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 99 in September 1953; lowest temperature -16 in February 1875; maximum monthly precipitation 13.27 in July 1947; minimum monthly precipitation 0.52 in October 1974; maximum precipitation in 24 hours 10.42 in July 1947; maximum snowfall in 24 hours 26.5 in December 1944.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

Source: National Climatic Center.

Conneaut Breakwater

Description and Effects on Site

2.562
The Conneaut harbor structures exert a major influence on the coastal processes in the vicinity of the site. The west breakwater, built in segments between 1912 and 1936, is almost 5,000 feet long and of rubblemound construction. A gap in the structure 16,000 feet from shore provides a small-boat entrance to the harbor. The top of the west breakwater is about 10 feet above low water data. The west breakwater has trapped a great deal of sand and gravel, creating a beach more than 2,000 feet long. It is about 700 feet wide near the wall and tapers westward to about 50 feet. A considerable amount of sand has passed over the west breakwater to form a protected beach inside the harbor with a shoal in the water off the beach. (2-141) The east breakwater built segmentally between 1905 and 1936 approximately 3,700 feet long and, like the west breakwater, of rubblemound construction. The east breakwater was not shore-connected until 1965 when approximately 1,000 feet of concrete cellular breakwater was constructed, extending to the existing rubblemound breakwater. A circulation gap is located between the older east breakwater and the more recent East breakwater extension. (2-141)

2.563
The primary effect these structures have had has been to interrupt the littoral drift of beach material eastward, thus starving the east adjacent shore of sand. Apparently, the west breakwater traps most of the sand in the longshore stream. (2-141) In effect, these structures have intercepted most of the natural flow of beach replenishment material which would normally be transported from west of Conneaut to the vicinity of the project site and beyond. Consequently, waves approaching the shore to the east of Conneaut erode the base of the bluffs more easily because of the lack of stable protective beaches. Other effects of the Conneaut harbor structures are noted below:

Isolation of Conneaut Creek Sediment - Conneaut Creek sediments, for the most part, are either trapped in the harbor or deposited offshore, rarely influencing the nearshore environment of the adjacent portions of the site.

Protection from the Westerly Waves - The site is in the shadow of the harbor and is thus partially protected by the harbor from waves from the west. The extent of protection decreases with distance from the harbor, and is probably minimal east of State Line Road.

2.564
Additionally, the shoreward arm of the east breakwater (constructed in 1965) has had a notable and severe effect on the shoreline immediately to the east. The vertical face of the N 38° W towards the shore, and the concentration of wave action has caused excessive erosion at the inner end of the shorearm. (2-145) Since 1972, the erosion has been exacerbated by high lake levels and mild winters. The severe erosion extends about 2,500 feet east of the shorearm to the vicinity of Thompson Road and included the loss of approximately 210 meters of a Bessemer & Lake Erie Railroad spur. Erosion rates along the most severely affected reaches have been at least seven feet per year in recent years. To improve the situation, the U.S. Army Corps of Engineers is contemplating the following alternative actions: (2-142)

> Alternative I - The installation of substantial quantities of stone on the lakeward face of the 3,300-foot east breakwater shorearm to minimize wave reflection, and the construction of a short rubblemound revetment about 83 feet long immediately east of the shorearm. The revetments will consist of a structure of graded stone and gravel constructed on the shoreline parallel to shore, whose purpose is to protect the bluff from the erosional action of waves.

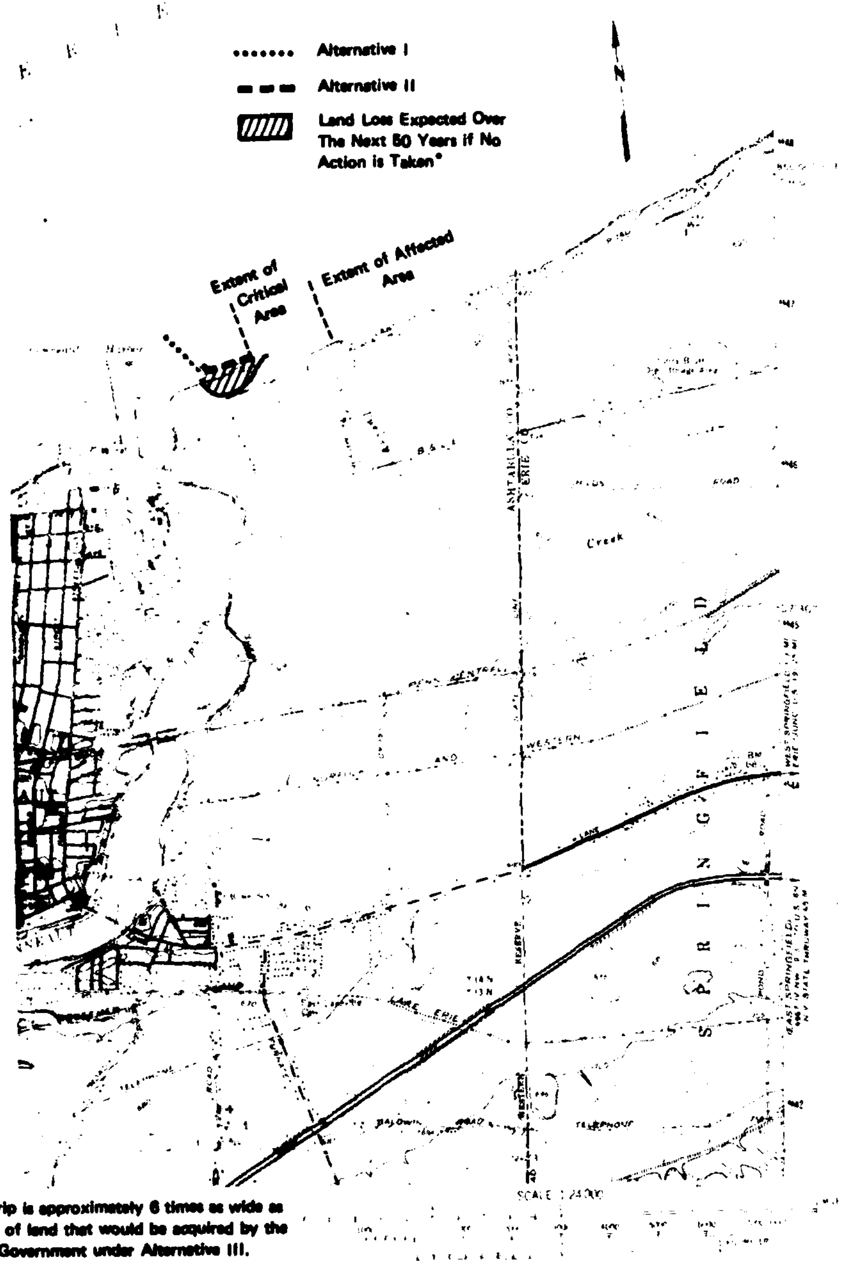
> Alternative II - The construction of a rubblemound revetment about 280 meters long, immediately east of the east breakwater shorearm.

> Alternative III - The acquisition, by the Federal Government, of a strip of land large enough to provide a minimum of 50 years of protection from the long-term erosion rates in the area. The public would be allowed access to the area as part of the plan.

These alternatives are shown schematically in Figure 2-87.

e) Fastland Erosion

2.565
The potential for soil erosion on the site is extremely varied due to the differences in soil, slope, and vegetative cover encountered. The sand and gravel strand deposits present at the site have a low to medium potential for soil erosion. While the glacial till materials have a medium potential for erosion in the native state. However, fill areas comprised of excavated and disturbed till have a higher potential of erosion. The fine strand deposits also have a high potential for soil erosion. The silty lacustrine materials have the



*This strip is approximately 6 times as wide as the strip of land that would be acquired by the Federal Government under Alternative III.

Source: Arthur D. Little, Inc.

FIGURE 2–87 ALTERNATIVE ACTIONS TO CORRECT EAST BREAKWATER STREAM EROSION

highest erosion potential of all the soils on the site due to high silt content. Well over 80 percent of the site is currently covered by soils of high erosion potential, largely derived from lacustrine and strand deposits, i.e. Conneaut and Swanton soil series (refer to Figure 2-81 and Table 2-310. For the most part, the high soil erosion potential found on the site is rarely fulfilled due to favorable topography and vegetative conditions. With the exception of the shoreline bluffs and the erosional ravines or swales created by the streams and creeks on the site, the site is relatively flat, sloping slightly towards Lake Erie at approximately 0.5 percent (0.5 meters/100 meters). Furthermore, approximately 75 percent of the site is covered by brush or is forested. In these flat, vegetated areas, annual erosion rates are likely to be less than 0.1 ton per acre per year in spite of the high erosion potential of the soil. Erosion in and around the stream beds is more severe. The disturbed land on the site (approximately 500 acres, or 10 percent of the site) may also experience fairly severe erosion. Where the disturbed land has remained relatively flat, erosion rates are estimated at one to five tons per acre per year. In those areas, however, where earth-moving activities have built up long lengths of steep slopes, soil erosion is likely to be occurring at rates as high as 200 tons per acre per year or more.

Atmospheric Regime

Limits of Analysis

2.566
Regulatory considerations make the Northeast Ohio/Northwest Pennsylvania Interstate Air Quality Control Region (AQCR) one geographic area of analysis. The AQCR is a basic planning unit of the U.S. Environmental Protection Agency (EPA) and State agencies involved in the attainment and maintenance of National Ambient Air Quality Standards (NAASQ) and the Prevention of Significant Deterioration (PSD) of air quality. In addition, several factors related to the specific nature of the proposed project and the AQCR resulted in the definition of other units of analysis. Due to the designation of non-attainment status in this and other neighboring AQCR's for photochemical oxidants, a multi-phase analysis was carried out. The three-county Regional Study Area was considered in the analysis for the impacts of hydrocarbon emissions (primary and secondary) or the formation of oxidants. The evaluation of potential applications of the emissions offset policy, as established by the involved review agencies, considered the entire states of Ohio and Pennsylvania. The analysis of impacts of the remainder of the criteria pollutants is focused on two geographic areas. Primary impacts, since they are to be evaluated by the EPA and State agencies in terms of concentrations in the ambient air at the "property" or

"fence" line, were modeled and discussed in the immediate environs of the plant site. Secondary and cumulative impacts were also evaluated in the Regional Study Area and Air Quality Control Region.

Meteorology and Climatology

2.567
The proposed Lakefront Plant site is situated on the southeast shore of Lake Erie where it is bisected by the Ohio-Pennsylvania border. The terrain rises gradually from the lakeshore in a series of ridges paralleling the shoreline to 495 feet above lake level, three to four miles inland, and to 990 feet above the lake at 15 miles inland. The Lake Erie region is located within the mid-latitude belt of prevailing westerly winds and experiences weather systems which migrate eastward. The climate can be described as humid continental, having cold, snowy winters and warm summers. Precipitation is well distributed throughout the year, though greater monthly totals generally occur during the warmer months. An annual average of 161 days (44 percent) experience at least 0.01 inches of rainfall. General climatic data for this region are summarized in Table 2-314. Data for this table were obtained from the National Weather Service station in Erie. While the Erie station is located approximately 25 miles east-northeast of the proposed plant, it is nevertheless representative of the general meteorology along the southeast shore of Lake Erie. Predominant winds in this region range from the south through west, caused by such large-scale systems as the Bermuda high pressure system, whose average position in the warmer months of the year is off the southeast coast of the United States, and polar air masses which frequently penetrate the midwestern section of the United States and move eastward producing westerly winds. The seasonal wind roses for the Conneaut-Erie area are presented in Figures 2-88 to 2-91. As these diagrams indicate, wind distributions in this area have strong southerly and westerly components demonstrating the influence of the large-scale weather system. Superimposed on these synoptic scale movements are air movements resulting from local effects in particular the proximity of Lake Erie. Winds resulting from the differential heating and cooling between the land and this large body of water (i.e., lake breezes) are typically light and less persistent than synoptic scale air movement. Local winds are thus difficult to detect in the seasonal wind roses. In order to estimate the frequency of lake breezes in this area, the Erie hourly wind data were sorted for incidents of lake breeze. Lake breeze winds, for the purpose of this analysis, are as those midday winds from the NW having a wind speed under 10 mph and exhibiting a diurnal shift, in direction. Since lake breeze is a summer phenomenon, only the months of May through September were considered in this analysis. Thirty-five days exhibited periods of lake breeze type air movement and during this period, 13 of the incidents occurred in August. During

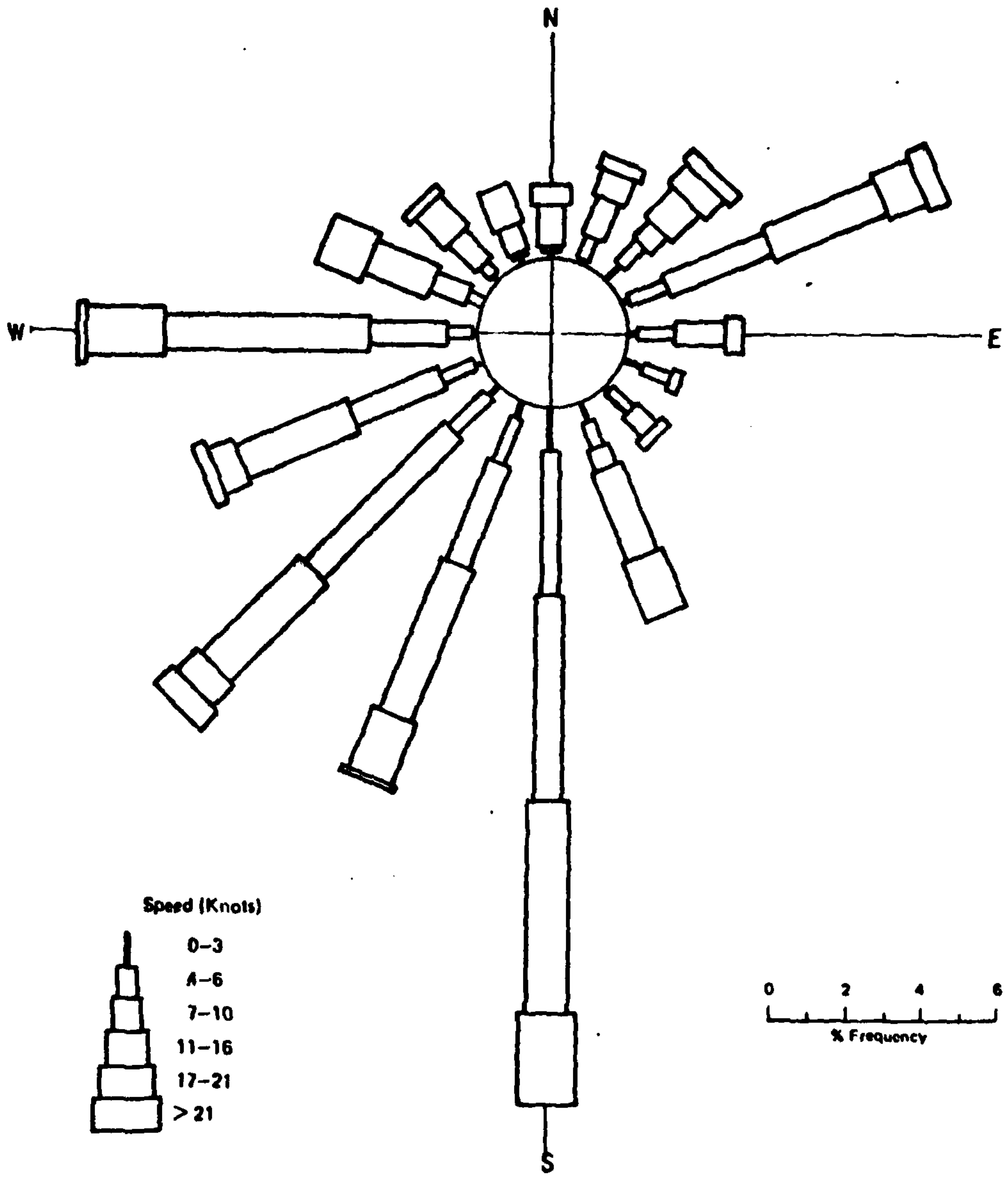


FIGURE 2–88 SEASONAL WIND ROSE FOR DECEMBER THROUGH FEBRUARY–ERIE, PENNSYLVANIA

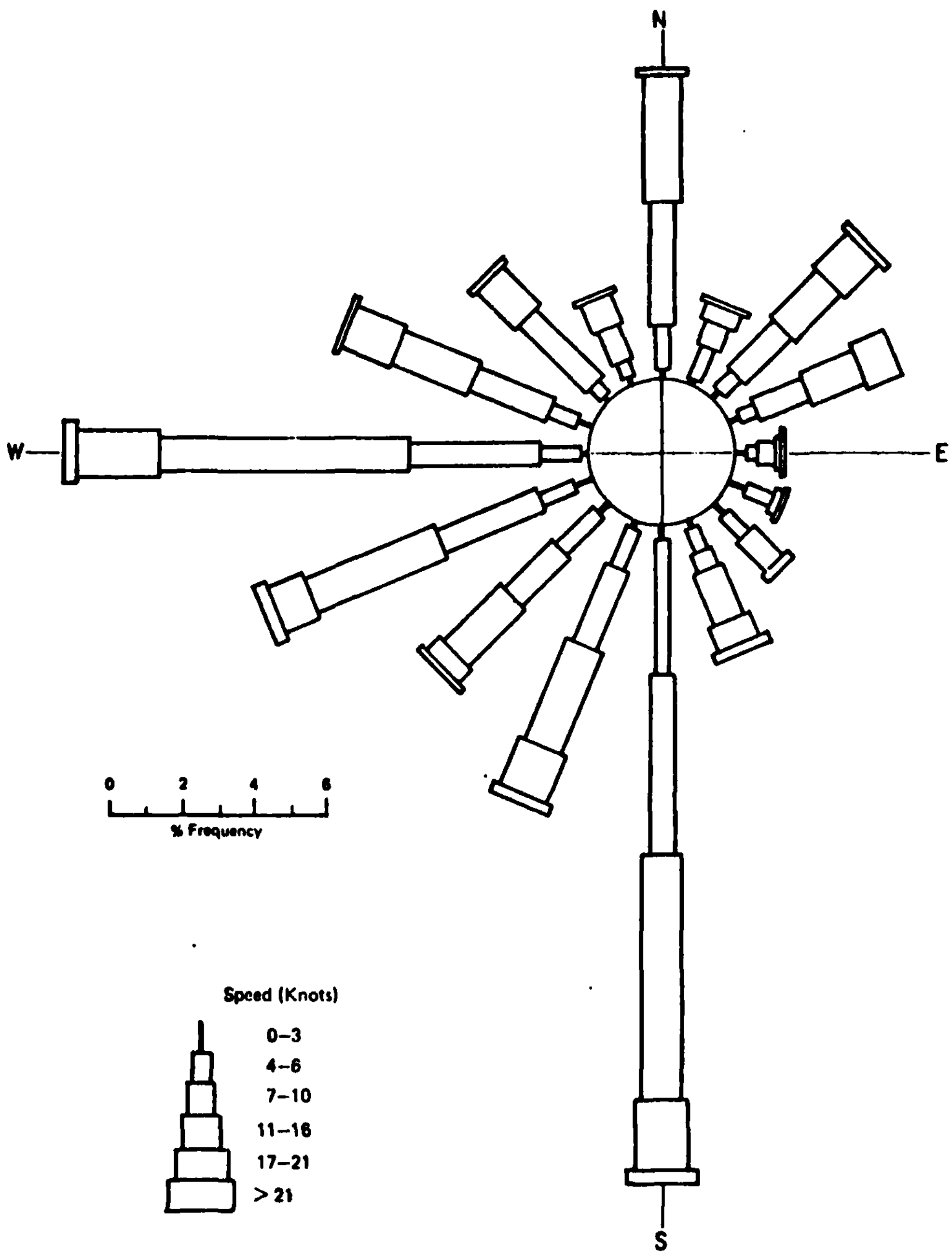


FIGURE 2–89 SEASONAL WIND ROSE FOR MARCH THROUGH MAY–ERIE, PENNSYLVANIA

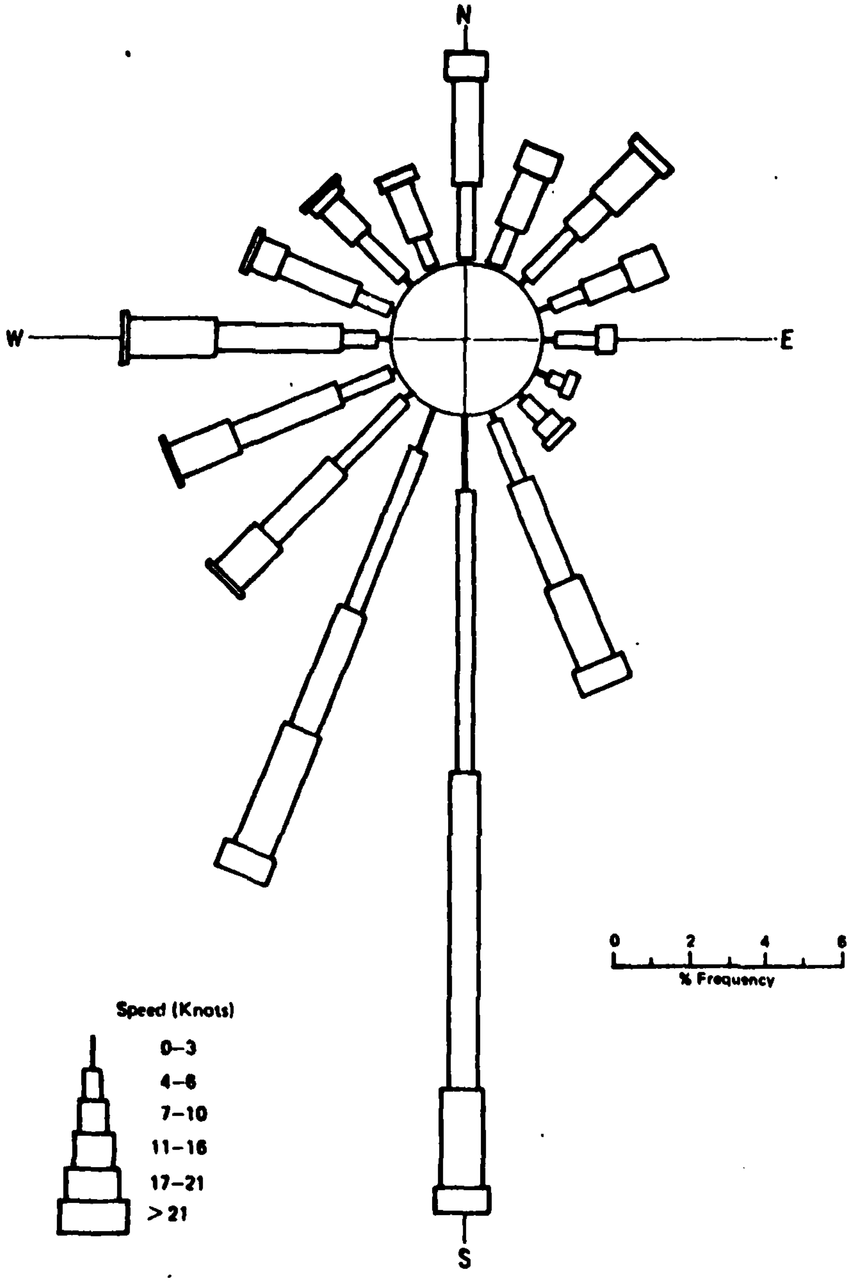


FIGURE 2–90 SEASONAL WIND ROSE FOR JUNE THROUGH AUGUST–ERIE, PENNSYLVANIA

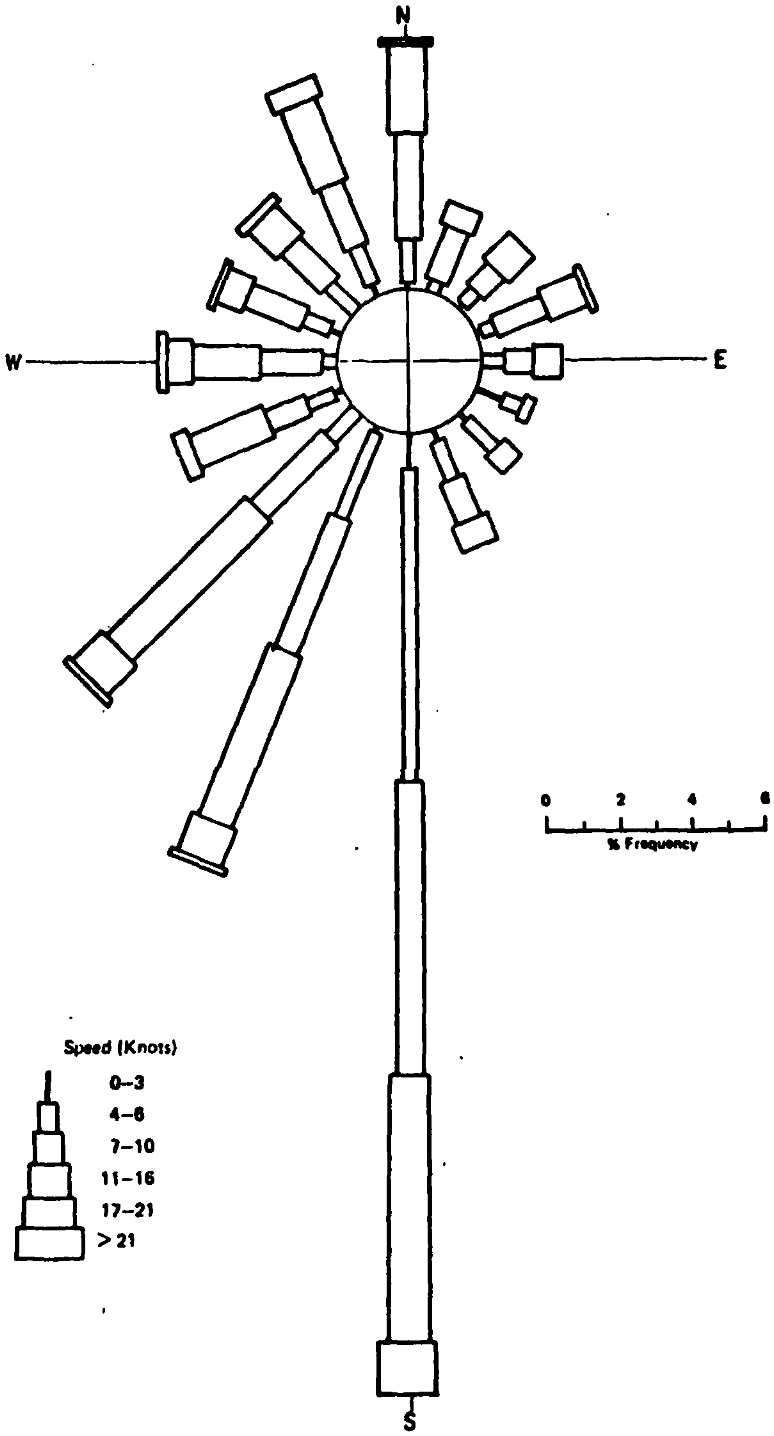


FIGURE 2–91 SEASONAL WIND ROSE FOR SEPTEMBER THROUGH NOVEMBER–ERIE, PENNSYLVANIA

the colder months, November through March, the proximity of Lake Erie also exerts a significant influence upon the climate of the Conneaut area. Polar and arctic air masses passing south or southeastward during this period acquire heat and moisture from contact with the lake waters. This increased heat and moisture content is responsible for the cloudiness and frequent snowfalls on the Lake Erie plain.

a) Basic Principles of Air Pollution Meteorology

2.568
The atmospheric dispersion of pollutants can be divided into three primary phases: the original rise of the effluent as it leaves its emission source; transport of the pollutants; and, downwind dispersion of the pollutants. When the effluent is first emitted from its source (i.e., an exhaust stack) it begins to interact with the surrounding environment. Most frequently factors within the ambient atmosphere, and within the plume itself interact to cause the plume to rise above its original emission height (the height of the stack) to some higher elevation, the effective stack height. The higher the plume rises, the lower the ground level concentrations. The plume rise depends on several interacting factors: the temperature difference between the plume and the atmosphere, cross sectional area of the stack, the upward velocity of the effluent as it leaves the stack and the ambient wind speed. While plume rise is generally considered a positive value, in cases where the efflux velocity is small, the plume may actually be brought downward at certain wind velocities (downwash). Briggs (2-146) presents a good summary of the mathematical formulae developed to predict plume rise from the meteorological and nonmeteorological parameters.

2.569
An emitted stack plume continues to rise buoyantly as long as it is warmer than the surrounding air. Thus, the variation of the air temperature with altitude is an important factor in determining plume rise. Air temperature is normally found to decrease with altitude up to about six miles. Under certain conditions, however, temperature may increase with height for limited vertical distances. These layers, "inversions," are common near the ground at night in rural terrain. Elevated inversions also occur more frequently in some regions than in others. Since it is the buoyant force resulting from a higher plume temperature that promotes plume rise, a plume rising into an atmosphere warming with altitude finds its buoyant force decreased till it can rise no more. Elevated inversions thus create a lid preventing the rise of effluent plumes into the atmosphere.

2.570
The temperature of the elevated layers of the atmosphere are determined twice daily by instrumented balloons (radiosondes) at selected

National Weather Service stations. The radiosonde station most representative of the meteorologic regime of the plant site is Buffalo, New York, 107 miles northeast of Conneaut. The thermal structure of the upper atmosphere is determined primarily by large-scale weather systems which are generally at least several hundred kilometers in diameter. Thus, the Buffalo data should usually be representative of conditions at the plant site. However, there are undoubtedly frequent occasions when they are nct indicative of conditions in Conneaut. Pollutants travel with the wind. Hourly wind observations, necessary for dispersion analyses, are available at many places, particularly airports. Unfortunately, such weather stations are normally several hundred kilometers apart, and good wind data are lacking in between. Further, the available wind data consist of ground level observations. Since pollutants normally travel with winds at 'igher levels, it is inappropriate to utilize ground level wind data for dispersion analyses without correction for altitude and local influences upon wind direction. For dispersion analyses, these problems have been dealt with by utilizing National Weather Service data from the closest lakeshore station and additionally setting up a meteorological observation station on a given site. The combination of these two sources of wind data provides for both a long-term wind record and a measure of how the more distant airport wind data are modified within a given area.

b) *Atmospheric Dispersion*

2.571
Dispersion of a contaminant in the atmosphere essentially depends on two factors: the mean wind speed and the characteristics of atmospheric "turbulence." To determine the effect of wind speed, consider a stack which emits one puff per second. If the wind speed is 10 m/sec, the puffs will be 10 meters apart; if it is five m/sec, the distance is five meters. Hence, the greater the wind speed, the smaller the concentration. Atmospheric "turbulence" consists of horizontal and vertical eddies which are able to mix the contaminated air with clean air surrounding it; hence, turbulence decreases the concentration of contaminants in the plume, and increases the concentration outside. The stronger the turbulence, the more the pollutants are dispersed. There are two mechanisms by which "eddies" are formed in the atmosphere: heating from below and wind shear. Heating produces convection. Convection occurs whenever the temperature decreases rapidly with height (i.e., whenever the lapse rate, or the rate of temperature change with height exceeds 10C/100m). It often penetrates into regions where the lapse rate is less. In general, convection occurs from the ground up to several hundred meters elevation on clear days and in cumulus-type clouds, and results from solar heating of the ground surface. The other type of turbulence, mechanical turbulence, occurs when the wind changes with height. Since there is no wind at ground level, and there usually is some wind above the ground, mechanical turbulence just above the ground is common. This type of turbulence increases with increasing wind speed

(at a given height) and is greater over rough terrain than over smooth terrain. The relative importance of heat convection and mechanical turbulence is presented diagrammatically in Figure 2-92. Smoke leaving a source into a convection atmosphere spreads rapidly, both vertically and laterally (refer to Figure 2-92a. As mechanical turbulence dominates, the angular dispersion decreases (refer to Figure 2-92b). Finally, as the atmosphere becomes stable and damps the mechanical turbulence, vertical mixing effectively disappears and only horizontal eddies remain (refer to Figure 2-92c).

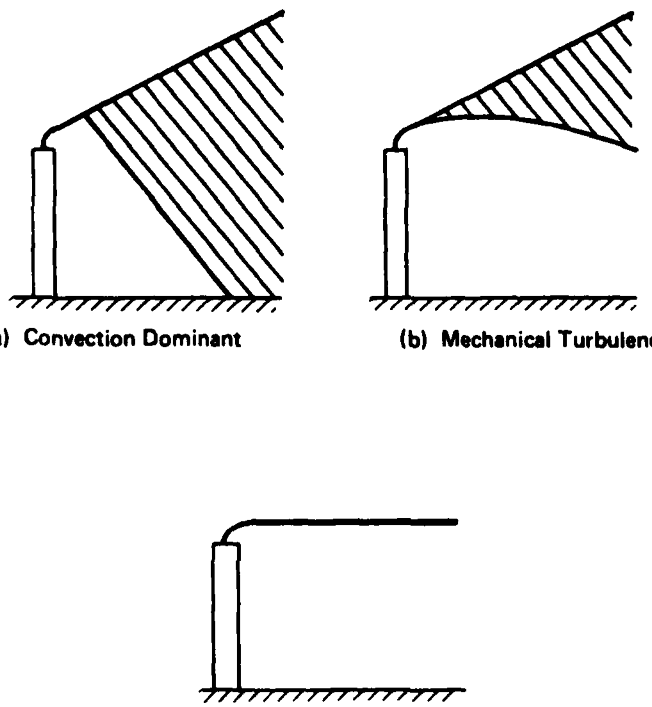
c) Estimating Concentrations of Contaminants

2.572
With the strength of a pollution source(s) and meteorological conditions as data source(s) the purpose of a dispersion analysis is to predict the expected pollutant concentrations in the vicinity of the source(s). The most successful method in current use is an empirical approach: the effluent dispersion is assumed to have a known geometrical distribution in which there is conservation of the effluent during the diffusion process. The usual assumption is that the distribution of effluent from a continuous source has a normal (Gaussian) distribution relative to the plume centerline both in the vertical direction, z, and in the direction perpendicular to the wind, y. Subject to the condition of continuity, the concentration is given by:

$$(1) \quad X(x,y,z;H) = \frac{Q}{2\pi \sigma y \sigma z y} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma z}\right)^2\right]\right\}$$

Where H is the "effective" height of the source, given by stack height plus additional rise, σ is the standard deviation of the distribution of concentration in the y and z-direction, respectively, and V is the wind speed, assumed constant. Q is the amount of contaminant emitted per unit time. The various techniques currently in use differ in the way σ_x and σ_z are determined. Clearly, these quantities change with downwind distance x (see Figure 2-93) and with atmospheric stability.

2.573
Quantitative estimation of the atmospheric stability requires quite sophisticated instrumentation. For the purposes of dispersion modeling, however, stability can be estimated by the wind speed, cloud cover and solar radiation. Thus, for example, on a clear night with little wind, the atmosphere is quite stable and 's in equation (1) are small; on the other hand, with strong winds the atmosphere is nearly neutral and the dispersion rate as indicated by the 's would be intermediate. The procedure used for estimating atmospheric stability in the Atmospheric Regime impact section of this statement is



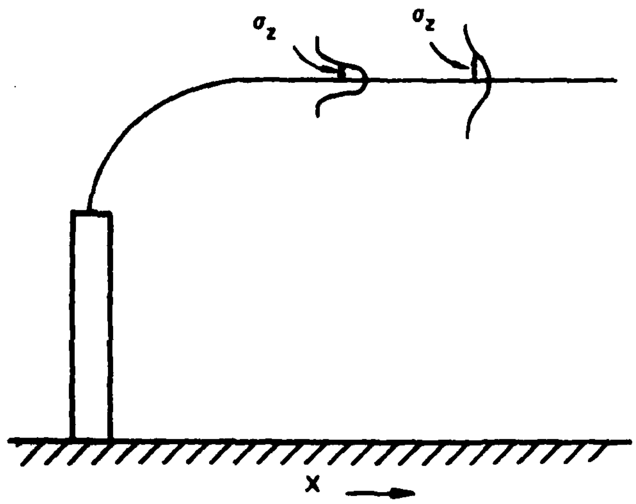
(a) Convection Dominant

(b) Mechanical Turbulence

(c) No Vertical Turbulence

Source: Panofsky, H.S., "Air Pollution Meteorology," *American Scientist,* 57, 2 pp. 269-285, 1969.

FIGURE 2–92 SPREAD OF POLLUTION FROM AN ELEVATED SOURCE



Source: Panofsky, H.S., "Air Pollution Meteorology", *American Scientist,* 57, 2 pp. 269-285, 1969.

FIGURE 2–93 VERTICAL DISTRIBUTION OF EFFLUENT AS A FUNCTION OF DISTANCE FROM THE SOURCE

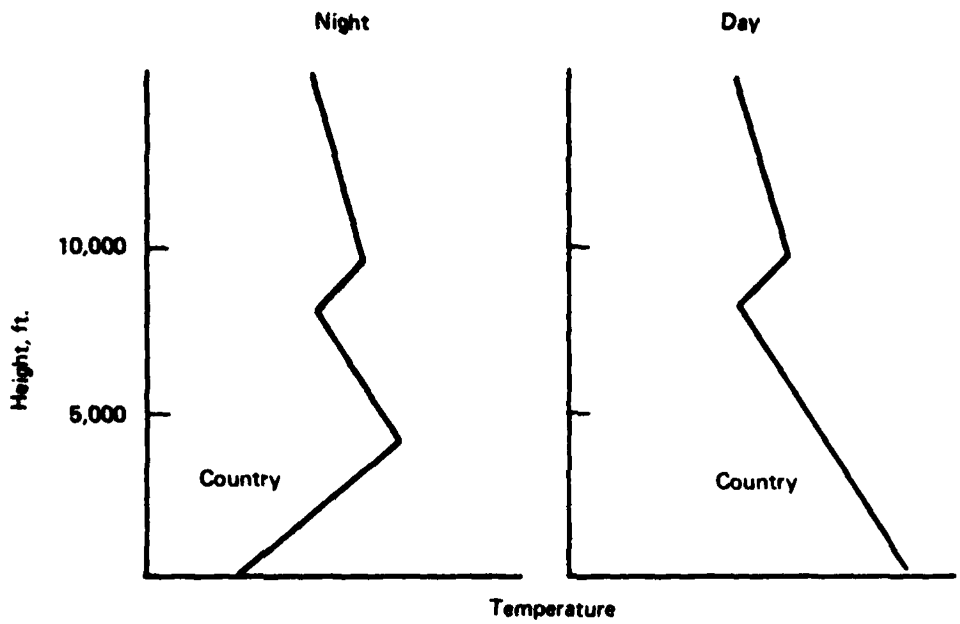
the one used by the National Climatic Center and which is known to allow adequate simulation of dispersion processes over a broad range of meteorological conditions. The most popular current method for estimating the standard deviations is the Pasquill-Gifford method in which y and z are determined by empirical graphs as a function of downwind distance x. This method, used in the applicant's dispersion analyses is discussed in greater detail in Turner. (2-148) It should be noted that the dependence of the standard deviation on x varies with the "stability category" (from A to F), where A (large dispersion) means little wind and strong convection; D is used in strong winds (strong mechanical turbulence and less dispersion); F applies at night in weak winds. The main drawback to the Pasquill-Gifford method is that there is no allowance for terrain roughness. This problem, however, is of relatively minor importance for this analysis, since the topography in the Conneaut area is a reasonably flat shoreline area. While a plume may initially disperse in the vertical dimension, this vertical distribution does not remain normal indefinitely. Dispersion is limited by the ground surface at the bottom and by an elevated inversion layer at the top. Eventually the vertical pollution distribution becomes nearly uniform. When this happens, ground level concentration is given by the equation:

$$(2) \qquad \chi = \frac{Q}{\sqrt{2\pi}\,\sigma_y V D} \exp\left[-\frac{y^2}{2\sigma_y^2}\right]$$

D being the height of the inversion layer which is also the thickness of the "mixed layer." In this calculation the concentration is inversely proportioned to VD, the product of the wind speed and the mixing height, commonly called the "ventilation factor."

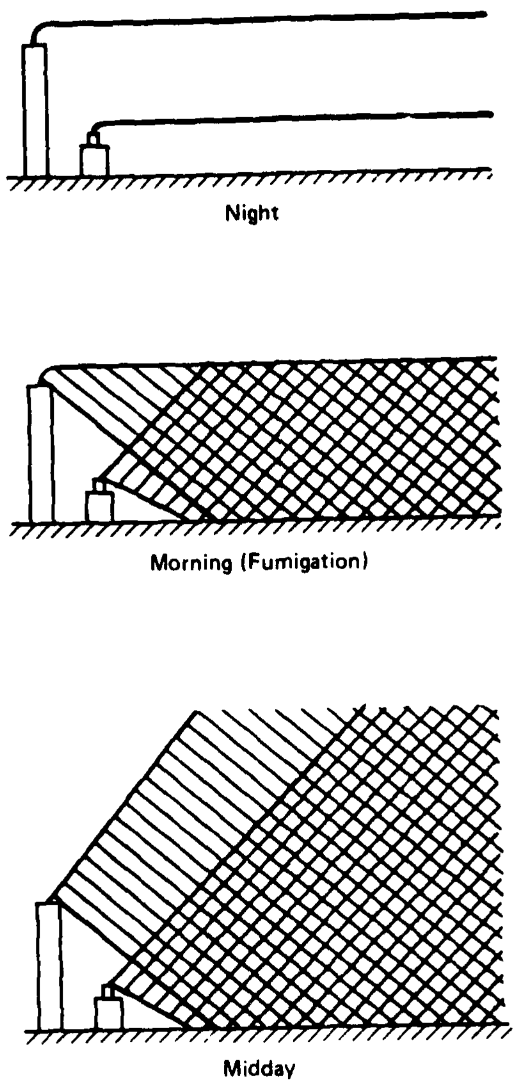
d) Diurnal Variation of Air Pollution

2.574
Equation (2) showing concentrations at considerable distances from individual sources to be inversely proportional to the ventilation factor (VD) can be used to explain some of the variations in air pollution caused by meteorological factors that vary with time of day. The typical vertical temperature profile is illustrated in Figure 2-94. Ground temperature is high during the day, giving a deep mixed layer. After sunset, the air temperature near the surface falls most rapidly producing an inversion reaching to ground level. Figure 2-95 indicates how the temperature changes shown in Figure 2-94 influence the diurnal variation of pollution due to an elevated source in the country. At night, vertical mixing is negligible and the air near the ground is clean. Some time shortly after sunrise,



Source: Panofsky, H.S., "Air Pollution Meteorology," *American Scientist,* 57, 2 pp. 269-285, 1969.

FIGURE 2–94 SCHEMATIC VERTICAL TEMPERATURE DISTRIBUTIONS



Source: Panofsky, H.S., "Air Pollution Meteorology," *American Scientist,* 57, 2 pp. 269-285, 1969.

FIGURE 2–95 NIGHT-TO-DAY VARIATION OF POLLUTION

the mixed layer extends to just above the source, and the elevated polluted layer is mixed with the ground air, leading to strong pollution (also referred to as "fumigation"), which may extend many kilometers away from the source. Later in the morning and early afternoon, the heating continues and thickens the mixed layer. During this period the wind speed also typically increases which tends to lower pollution levels. The dispersion models utilized in this analysis take these problems of diurnal variation into account by utilizing real time meteorological data to calculate ground level concentrations. Hourly wind and mixing height data were obtained from the National Weather Service for 1976. With this data it was possible to correct for hourly changes in meteorological conditions when calculating 24-hour averages for expected pollution levels.

e) Effects of Lake Breeze Upon Pollutant Dispersion

2.575
The complete analysis of meteorological conditions at a location near a large body of water, such as the proposed Lakefront Plant site, must include adequate consideration of the lake breeze, which is induced by temperature contrasts between land and the lake. As will be explained below, a lake breeze can cause higher ground level concentrations of SO_2 and other effluents than would occur without it. From around March through August, the temperature of air over Lake Erie is generally below that of the (daytime) maximum temperatures occurring over the land. In the absence of large-scale winds strong enough to overwhelm the small scale or local influences, this temperature difference gives rise to the so-called lake breeze. The breeze occurs during the day in the form of an inland movement of cold air from off the lake. This cold air moves in displacing the warmer, lighter air situated over the land. As the colder air flows inland it is heated rapidly from below, changing over a relatively short distance from a "night" to a "day" boundary layer. As discussed by Lyons (2-147) the boundary layer, thus formed, increases rapidly in depth from ground level at the shore line to as much as one kilometer by the time it has penetrated six miles inland, to even greater depths farther inland. This curved boundary layer, termed the thermal internal boundary layer (TIBL) by Lyons, separates the higher stable air, where dispersion is limited, from lower air in which penetrative convection is occurring and dispersion is vigorous.

2.576
When plumes are emitted along the lake shore and move inland with the lake breeze, they may at first rise above the TIBL due to their buoyancy and emission height or they may be immediately trapped underneath the TIBL's inversion lid. Those plumes rising into the upper air will show limited vertical diffusion as they travel [illegible] When such a plume intersects the curved TIBL at some

distance inland, it will be mixed downward rapidly by the turbulent lower air causing a fumigation "hot spot" some distance inland from the pollution source. Since this daytime boundary layer may be present for several hours during days of light onshore breezes, there is considerable potential for "lake breeze fumigation" to result in high ground level pollution concentrations within the limited area of the hot spot. It should be noted here that while Lyon's observations noted the persistance of the fumigation incident, movement of the resulting hot spot over the ground surface was also observed. This hot spot movement was a result of the light, variable winds of the lake breeze and gradual changes in the TIBL itself. Thus, while lake breeze fumigation may occur for several hours, the probability of any one area receiving the major impact of the pollutants is rather low. Cases of high impact from lake breeze fumigation are likely to occur only when a lake breeze is directionally persistent for several hours and wind speed is low.

2.577
Persistence would limit the movement of a fumigation hot spot while low wind spead would tend to increase ground level concentrations. The frequency of these incidences was investigated by sorting the Erie 1976 hourly wind data as was done previously for lake breeze frequency. When these data were evaluated for midday, on shore winds having three-hour persistence and speeds five mph or less, only seven days were identified. As would be expected, this was only a fraction of the total number of days identified in the climatological discussion of lake breeze frequency. Fumigation conditions thus have a low (under five percent) but real probability of occurrence during the warmer months and warrant investigation. When released directly into the unstable mixing layer, the plume is trapped underneath the TIBL lid, displays looping behavior, and produces maximum ground level concentrations near the source. Since the proposed site will be a combination of relatively tall, high temperature pollution sources and low level, cool sources, it is expected that both of these dispersion conditions, fumigation and looping, will occur simultaneously in different plumes. Thus, downwind concentrations can be expected to result from the additive effects of several sources. In order to adequately treat the meteorological phenomenon of lake shore fumigation, a specialized dispersion model, AQSTM, has been utilized as part of the air quality analysis. AQSTM has the capability to consider plume interaction with a curved TIBL in both the intersection and trapping instances. As such AQSTM is well suited for evaluating potential shoreline fumigation incidents.

Ambient Air Quality

2.578
The term "air quality" is used to describe the state of cleanliness of the ambient air in a specified locality, area, or region. Air

quality is degraded by the presence of air contaminants or "pollutants" in the form of gases, liquid droplets, or solid particles. The effects of air pollutants include hazards of health, damage to property and vegetation, restraint of activities because of a reduction in visibility, and esthetic or nuisance effects such as smoke plumes and odors. Air quality may be expressed directly in terms of ambient concentrations of air pollutants or indirectly in terms of effects, such as reduction in visibility or odor level. Air pollutants are emitted into the ambient air by both natural and man-made sources. Natural sources include vegetation, wind-generated dust, volcanoes, and lightning. Man-made sources include mobile and stationary combustion systems, industrial processes, domestic, institutional, and commercial heating systems, and agricultural and other waste disposal activities. Quantitative information on rates of pollutant emission in a particular region is necessary to determine the sources contributing to degraded air quality and to plan air quality control measures. A summary of emission rates for sources in a region is called an "emission inventory." An emission inventory may be expressed in terms of total emissions per unit of area.

2.579
Air quality at a specific location or within a region is dependent upon the magnitude and distribution of emission sources in the region and also on the meteorological factors which affect the transformation and transport of emissions from these sources. In addition to wind speed near ground level, these factors include the stability of the atmosphere. Atmospheric stability refers to the processes that cause vertical and lateral mixing or spreading of air pollutants as they are carried away from their sources by the wind. Stability is characterized by rates of diffusion associated with atmospheric turbulence and by a mixing height which is the upper elevation of the meteorological mixing layer. Vertical diffusion of pollutants occurs very slowly above the mixing layer in comparison with diffusion rates within the layer. Thus, the mixing height is a measure of the altitude to which pollutants can be expected to diffuse in their passage through the atmosphere. Air quality at a specific location is the result of all sources whose emissions are transported to that location by the processes of meteorological dispersion. This result is termed the "impact" of these sources on the air quality at that location. Each source is considered to have its individual impact on the local air quality, and the combined effect of all sources is the total air quality impact. Both Federal and State regulations are designed to regulate air emissions in order to achieve, maintain, and protect ambient air quality. The Federal Clean Air Act of 1970, amended in 1977, established the framework for Federal and State air regulations. The proposed project site is located on the border of Ohio, and Pennsylvania in Ashtabula County,

Ohio, and Erie County, Pennsylvania, respectively. The site is bordered by Conneaut, Ohio, on the west, Route 20 on the south, Raccoon Creek on the east.

2.580
Estimates of the annual rates of pollutant emissions from both point and area sources in 1976 are summarized in Table 2-315 for a seven-county region surrounding the proposed site. These counties represent regions from which pollutants are most likely to be transported by diffusion and/or meteorological conditions to the project area. Data for area source in Pennsylvania have not been compiled at this time, so estimates based on population are used in computing impacts and secondary development. During 1976, five hi-volume samplers and one continuous monitoring station were operated in the Erie Air Basin by the Bureau of Air Quality and Noise Control of the Pennsylvania Department of Environmental Resources. Similarly in Ashtabula, the Ohio EPA operated seven hi-volume samplers, two sulfur dioxide monitors, and one each for ozone and nitrogen dioxide. The data for the two counties are summarized in Tables 2-316 and 2-317, respectively. On the basis of the annual historical data, Conneaut has no violations of the total suspended particulate standard. A single hi-volume sampler installed at 770 Lake Road (number 6 in Table 2-316) recorded a second highest 24-hour maximum ground level concentration of 129 ug/m^3. The monitoring data indicate that Ashtabula and Erie Counties are attainment areas for both sulfur dioxide and nitrogen dioxide. The USEPA has determined that the entire Commonwealth of Pennsylvania and 63 counties in the State of Ohio are nonattainment areas for oxidants. In Conneaut, the recorded high concentration for oxidants was 132 ug/m^3. More industrialized Erie, on the other hand, exceeded the primary standard 86 times in 1976 with a maximum hourly average of 278 ug/m^3 and a second maximum hourly average of 256 ug/m^3.

2.581
For the purposes of determining the impacts of the proposed plant, the annual historical air quality data were found to be insufficient for two reasons: 1) the monitors did not adequately represent the air quality near the project, and 2) many of the pollutants of concern were not recorded. Consequently, in order to further facilitate an assessment of the ambient air quality at the proposed site, a meteorological and air quality monitoring program was instituted by Environmental Research & Technology, Inc. (ERT), to determine baseline air quality at the proposed plant site. ERT provided, installed, operated, calibrated, and maintained meteorological and air quality monitoring stations at the site. The locations of the monitoring stations are shown in Figure 2-96. A ground level meteorological monitoring station was located in the Perry Bluff Ore

Table 2-315

Estimates of Annual Pollutant Emissions from Both Point and Area Sources -- 1976
(Tons/Year)

County, State		Particulates	Sulfur Dioxide	Nitrogen Oxide	Hydrocarbons	Carbon Monoxide
Lake, OH	Area	7,591	8,229	9,357	15,356	72,582
	Point	13,031	219,209	34,366	13,516	1,351
Trumbull, OH	Area	17,173	11,343	13,959	21,534	101,107
	Point	17,247	48,618	20,386	2,884	10,593
Ashtabula, OH	Area	4,405	4,970	5,962	8,640	41,824
	Point	21,331	78,291	11,797	350	765
Geauga, OH	Area	2,093	2,014	4,263	5,997	27,246
	Point	65	339	26	1	4
Erie, PA	Area	-	2,476	-	-	-
	Point	31,113	43,548	35,156	4,399	16,033
Crawford, PA	Area	-	-	-	-	-
	Point	1,067	7,910	2,238	551	178
Mercer, PA	Area	-	-	-	-	-
	Point	4,541	3,522	925	2,132	40,623

Source: Ohio Environmental Protection Agency and Pennsylvania Department of Environmental Resources.

Table 2-316

Air Quality Data for Ashtabula County (1976)

Station	Particulates ($\mu g/m^3$)		SO_2 ($\mu g/m^3$)		NO_2 ($\mu g/m^3$)	Ozone ($\mu g/m^3$)
Number	Max-24 hr.	Geom. Mean	Max-24 hr.	Arith. Mean	Arith. Mean	Max-1 hr.
(1)	244	73.68	152	34.42	46.25	-
(2)	143	60.10	-	-	-	-
(3)	129	54.30	-	-	-	-
(4)	159	65.72	231	45.0	-	-
(5)	122	40.88	-	-	-	-
(6)*	135	53.58	-	-	-	132
(7)*	140	41.27	-	-	-	-

*Located in Conneaut.

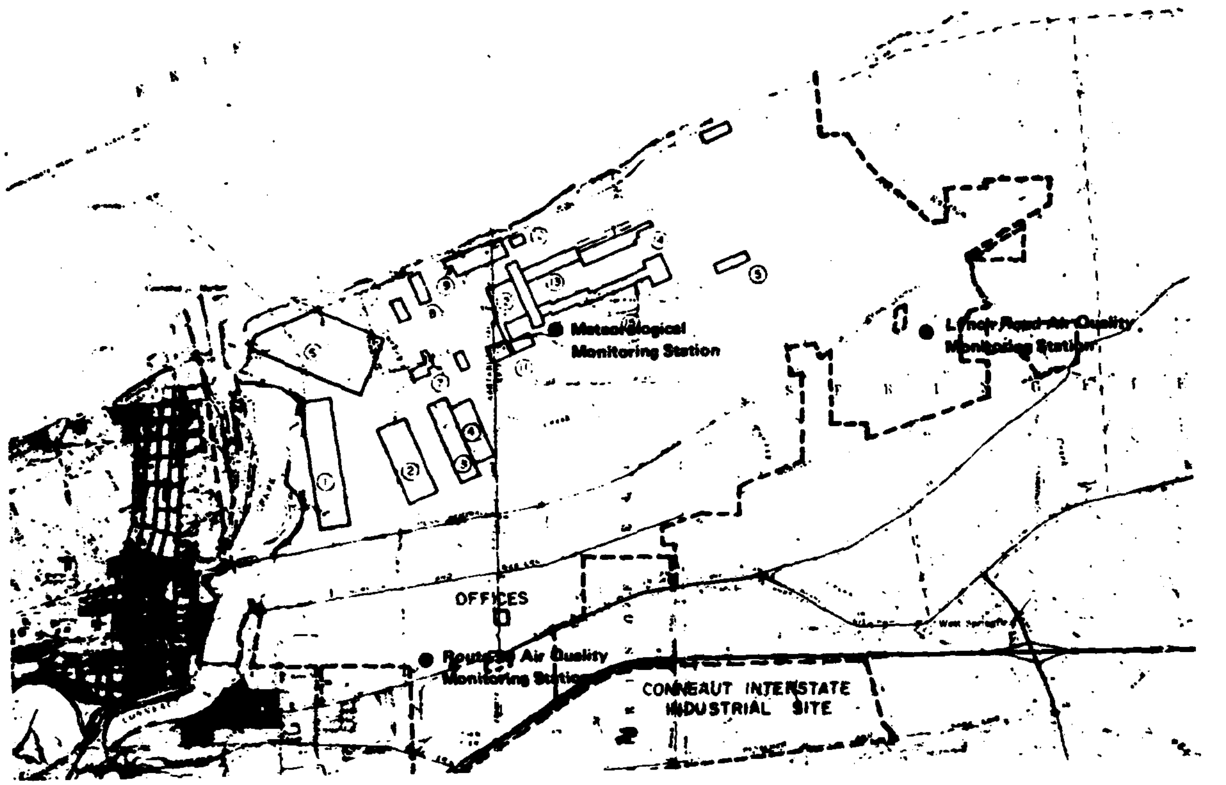
SOURCE: OHIO EPA

Table 2-317

Air Quality Data for Erie County

Station Number	Particulates ($\mu g/m^3$)		SO_2 ($\mu g/m^3$)		NO_2 ($\mu g/m^3$)	Ozone ($\mu g/m^3$)
	Max-24 hr.	Geom. Mean	Max-24 hr.	Arith. Mean	Arith. Mean	Max-1 hr.
(1)	-	-	-	-	52.0	278
(2)*	181	40	-	-	-	-
(3)	446	70	-	-	-	-
(4)	187	64	-	-	-	-
(5)	674	112	-	-	-	-
(6)	179	38	-	-	-	-
(7)	-	-	184	29	-	-

*Station in Pennsylvania that is closest to the site (18 mi. E.) where secondary standard has been exceeded.



PROPERTY LINES
1. COAL STORAGE
2. COAL BLENDING
3. COKE OVENS
4. COKE OVEN BY-PRODUCTS PLANT
5. MAINTENANCE SHOPS
6. RAW MATERIAL STORAGE
7. POWER HOUSE
8. SINTER PLANT
9. WATER INTAKE AND TREATMENT
10. OXYGEN PLANT
11. BLAST FURNACES
12. STEELMAKING AND CASTING
13. HOT STRIP MILL
14. STRIP FINISHING
15. PLATE MILL

FIGURE 2–96 LOCATION OF METEOROLOGICAL AND AIR QUALITY MONITORING STATIONS ON THE PROPOSED LAKEFRONT PLANT SITE

Storage Area near the center of the site. The two air quality monitoring stations were located near the southwestern and eastern property lines based on guidance provided by the appropriate Federal and State regulatory agencies. Equipment at the ground level one monitoring station consisted of: Climet Model WD12-10 wind direction sensor, Climet Model WS-011-1 wind speed sensor, Climet temperature sensor, Climet dewpoint sensor, MRI rain gauge, and Esterline Angus Recorders. Equipment at the air quality monitoring stations consisted of: Model SA-185-2A SO_2 Analyzers, TECO Model 14B NO_2 Analyzers, Monitor Labs Model 8410E O_3, Analyzers, Bendix Model 8501-5CA CO Analyzers, Monitor Labs Model 8500 Calibrator (3-Gas), Bendix Model 8201 Hydrocarbon Analyzers, ERT High Volume Samplers. The equipment described above for sampling SO_2, O_3, and CO are considered reference or equivalent in accordance with regulatory guidelines. All other listed equipment was not evaluated for equivalency. The operation, maintenance, and calibration of air quality and meteorological equipment by ERT were performed in accordance with standards that meet, and in some cases exceed, those set forth by the manufacturer and USEPA. For air quality parameters, the calibration span value was automatically output daily on the analog strip chart. In addition, the field technician made a manual calibration check of all air quality and meteorological parameters during his routine site visits. All air quality and meteorological instrumentation was subject to overhaul and recalibration semiannually, or more often as necessary. Documentation was generated at all operational levels to demonstrate acceptable calibration.

2.582
Collected data were reduced to hourly averages by ERT. The data were checked for errors, edited, and processed into monthly summary reports. Data were also acquired by ERT from the National Weather Service Station at Erie. The quality assurance methodology for data collections was generated by ERT and approved by EPA Regions III and V and the counterpart State agencies. Since the Draft EIS was printed, a full year of data has been collected and summaries of these data are presented in Tables 2-318 through 2-323. These data replace the five months of monitoring data that were given in the Draft EIS.

2.583
The burning of high sulfur fuels in stationary sources and in space heating are the primary sources of sulfur oxides. Concentrations of sulfur dioxide during the warmer months are expected to be generally lower than those observed in winter. The higher winter contributions represent increased fuel consumption for uses such as heating. The state data show that, on the average, sulfur dioxide levels in the area are one-half the national standard, while Tables 2-318a through

Table 2-318a

3-Hour Running Average for Sulfur Dioxide - Route 20 Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
13	0.005	33.863	33.863
27	0.010	18.800	52.663
40	0.015	12.070	64.732
54	0.020	10.918	75.650
67	0.025	8.009	83.659
81	0.030	5.213	88.872
94	0.035	3.204	92.075
108	0.040	2.192	94.267
121	0.045	1.588	95.855
135	0.050	0.984	96.838
202	0.075	2.698	99.536
369	0.100	0.393	99.930
404	0.150	0.070	100.000
538	0.200	0.0	100.000
673	0.250	0.0	100.000
857	0.300	0.0	100.000
942	0.350	0.0	100.000
1076	0.400	0.0	100.000
1211	0.450	0.0	100.000
1346	0.500	0.0	100.000
Values	0.500	0.0	100.000

Average = 0.01375

Geometric Average = 0.00793

Number of Values = 7117

Standard Deviation = 0.01419

Geometric Standard Deviation = 3.08828

Federal Standard = 1300 $\mu g/m^3$

Table 2-318b

24-Hour Running Average for Sulfur Dioxide - Route 20 Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
3	0.001	0.0	0.0
8	0.003	9.813	9.813
11	0.004	7.001	16.814
16	0.006	7.156	23.970
19	0.007	6.678	30.648
21	0.008	6.214	36.862
27	0.010	5.989	42.851
30	0.011	6.565	49.417
35	0.013	5.820	55.237
32	0.014	5.314	60.551
57	0.021	19.724	80.275
75	0.028	9.391	89.667
113	0.042	8.210	97.877
151	0.056	2.053	99.930
188	0.070	0.070	100.000
226	0.084	0.0	100.000
264	0.098	0.0	100.000
301	0.112	0.0	100.000
339	0.126	0.0	100.000
377	0.140	0.0	100.000
Values	0.140	0.0	100.000

Average = 0.01375

Geometric Average = 0.01011

Number of Values = 7113

Standard Deviation = 0.01039

Geometric Standard Deviation = 2.31529

Federal Standard = 365 $\mu g/m^3$

Table 2-318c

3-Hour Running Average for Sulfur Dioxide - Lynch Road Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
13	0.005	38.799	38.799
27	0.010	17.610	56.409
40	0.015	12.803	69.212
54	0.020	9.060	78.272
67	0.025	7.966	86.238
81	0.030	4.253	90.491
94	0.035	2.980	93.471
108	0.040	1.812	95.283
121	0.045	1.273	96.556
135	0.050	0.809	97.364
202	0.075	1.677	99.042
269	0.100	0.689	99.730
404	0.150	0.270	100.000
532	0.200	0.0	100.000
673	0.250	0.0	100.000
807	0.300	0.0	100.000
842	0.350	0.0	100.000
1076	0.400	0.0	100.000
1211	0.450	0.0	100.000
1346	0.500	0.0	100.000
Values	0.500	0.0	100.000

Average = 0.01269

Geometric Average = 0.00692

Number of Values = 6678

Standard Deviation = 0.01462

Geometric Standard Deviation = 3.18320

Federal Standard = 1300 $\mu g/m^3$

Table 2-318d

24-Hour Running Average for Sulfur Dioxide - Lynch Road Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
3	0.001	0.0	0.0
8	0.003	14.602	14.602
11	0.004	9.515	24.117
16	0.006	8.618	32.735
19	0.007	5.236	37.971
21	0.008	5.132	43.103
27	0.010	6.254	49.357
30	0.011	5.955	55.311
35	0.013	4.129	59.440
38	0.014	4.264	63.704
57	0.021	18.312	82.017
75	0.028	9.620	91.637
113	0.042	6.538	98.175
151	0.056	1.167	99.342
188	0.070	0.254	99.596
226	0.084	0.374	99.970
264	0.098	0.030	100.000
301	0.112	0.0	100.000
339	0.126	0.0	100.000
377	0.140	0.0	100.000
Values	0.140	0.0	100.000

Average = 0.01270

Geometric Average = 0.00873

Number of Values = 6684

Standard Deviation = 0.01098

Geometric Standard Deviation = 2.50470

Federal Standard = 365 $\mu g/m^3$

Table 2-319a

Hourly Average Carbon Monoxide - Route 20 Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
0.4	0.350	5.536	5.536
0.8	0.700	10.363	15.899
1.2	1.050	5.942	21.841
1.6	1.400	3.731	25.573
2.6	1.750	3.366	38.939
2.4	2.100	8.294	27.234
2.8	2.450	8.842	46.076
3.3	2.800	13.486	59.562
3.7	3.150	11.073	70.635
4.1	3.500	9.207	79.842
6.1	5.200	19.935	99.777
8.3	7.000	0.223	100.000
12.4	10.500	0.0	100.000
16.5	14.000	0.0	100.000
20.6	17.500	0.0	100.000
24.7	21.000	0.0	100.000
28.9	24.500	0.0	100.000
33.0	28.000	0.0	100.000
37.1	31.500	0.0	100.000
40.0	35.000	0.0	100.000
Values	35.000	0.0	100.000

Average = 2.41145

Number of Values = 4931

Standard Deviation = 1.29051

Federal Standard = 40 $\mu g/m^3$

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Table 2-319b

8-Hour Running Average for Carbon Monoxide - Route 20 Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
0.1	0.090	3.648	3.648
0.2	0.180	0.512	4.160
0.3	0.270	0.512	4.672
0.4	0.360	0.934	5.606
0.5	0.450	1.913	7.519
0.6	0.540	5.095	12.614
0.7	0.630	1.780	14.394
0.8	0.720	1.802	16.196
0.9	0.810	1.491	17.686
1.0	0.900	2.002	19.689
1.5	1.350	6.630	26.318
2.1	1.800	3.960	30.278
3.1	2.700	26.496	56.774
4.2	3.600	24.672	81.446
5.3	4.500	15.884	97.330
6.3	5.400	2.625	99.955
7.4	6.300	0.044	100.000
8.5	7.200	0.0	100.000
9.4	8.100	0.0	100.000
10.0	9.000	0.0	100.000
Values	9.000	0.0	100.000

Average = 2.36671

Number of Values = 4495

Standard Deviation = 1.27429

Federal Standard = 10 $\mu g/m^3$

Table 2-319c

Hourly Average Carbon Monoxide - Lynch Road Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
0.4	0.350	75.077	75.077
0.8	0.700	17.535	92.612
1.2	1.050	3.000	95.612
1.6	1.400	3.360	98.971
2.0	1.750	0.549	99.520
2.4	2.100	0.377	99.897
2.8	2.450	0.069	99.966
3.3	2.800	0.034	100.000
3.7	3.150	0.0	100.000
4.1	3.500	0.0	100.000
6.1	5.200	0.0	100.000
8.2	7.000	0.0	100.000
12.3	10.500	0.0	100.000
16.5	14.000	0.0	100.000
20.6	17.500	0.0	100.000
24.7	21.000	0.0	100.000
28.9	24.500	0.0	100.000
33.0	28.000	0.0	100.000
37.1	31.500	0.0	100.000
40.0	35.000	0.0	100.000
Values	35.000	0.0	100.000

Average = 0.22756

Number of Values = 5834

Standard Deviation = 0.33973

Federal Standard = 40 $\mu g/m^3$

Table 2-319d

8-Hour Running Average for Carbon Monoxide - Lynch Road Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
0.1	0.090	48.205	48.205
0.2	0.180	11.721	59.926
0.3	0.270	9.504	69.430
0.4	0.360	6.653	76.082
0.5	0.450	5.544	81.626
0.6	0.540	6.318	87.944
0.7	0.630	3.291	91.235
0.8	0.720	1.566	92.802
0.9	0.810	0.898	93.699
1.0	0.900	0.880	94.579
1.5	1.350	4.118	98.698
2.1	1.800	1.091	99.789
3.2	2.700	0.211	100.000
4.2	3.600	0.0	100.000
5.3	4.500	0.0	100.000
6.3	5.400	0.0	100.000
7.4	6.300	0.0	100.000
8.5	7.200	0.0	100.000
9.4	8.100	0.0	100.000
10.0	9.000	0.0	100.000
Values	9.000	0.0	100.000

Average = 0.23118

Number of Values = 5682

Standard Deviation = 0.31844

Federal Standard = 10 $\mu g/m^3$

Table 2-320a

3-Hour Running Average for THC Less CH4 - Lynch Road Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
1	0.002	25.105	25.105
3	0.005	5.021	30.126
5	0.007	4.184	34.310
7	0.010	0.0	34.310
8	0.012	3.766	38.075
9	0.014	2.092	40.167
11	0.017	0.0	40.167
13	0.019	4.184	44.351
15	0.022	2.092	46.443
16	0.024	0.418	46.862
24	0.036	7.950	54.812
32	0.048	7.950	62.761
48	0.072	14.226	76.987
65	0.096	5.021	82.008
81	0.120	6.276	88.284
97	0.144	3.347	91.632
113	0.168	2.929	94.561
120	0.192	0.837	95.397
145	0.216	1.255	96.653
160	0.240	2.510	99.163
Values	0.240	0.837	100.000

Average = 0.04859

Number of Values = 239

Standard Deviation = 0.05958

Federal Standard = 160 $\mu g/m^3$

Table 2-320b

3-Hour Running Average for THC Less CH4 - Route 20 Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
1	0.002	2.564	2.564
3	0.005	0.0	2.564
5	0.007	0.0	2.564
7	0.010	0.0	2.564
8	0.012	0.0	2.564
9	0.014	2.564	5.128
11	0.017	0.0	5.128
13	0.019	0.0	5.128
15	0.022	0.0	5.128
16	0.024	2.564	7.692
24	0.036	2.564	10.256
32	0.048	15.385	25.641
48	0.072	17.949	43.590
65	0.096	17.949	61.538
81	0.120	2.564	64.103
97	0.144	15.385	79.487
113	0.168	0.0	79.487
129	0.192	5.128	84.615
145	0.216	5.128	89.744
160	0.240	2.564	92.308
Values	0.240	7.692	100.000

Average = 0.10168

Number of Values = 39

Standard Deviation = 0.06985

Federal Standard = 160 $\mu g/m^3$

Table 2-321a

Hourly Average Nitrogen Dioxide -- Route 20 Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
20	0.010	58.446%	58.446%
41	0.020	25.577	84.023
62	0.030	9.498	93.521
82	0.040	3.663	97.184
103	0.050	1.628	98.813
123	0.060	0.712	99.525
144	0.070	0.407	99.932
164	0.080	0.068	100.000
185	0.090	0.0	100.000
205	0.100	0.0	100.000
308	0.150	0.0	100.000
411	0.200	0.0	100.000
616	0.300	0.0	100.000
822	0.400	0.0	100.000
1027	0.500	0.0	100.000
1232	0.600	0.0	100.000
1438	0.700	0.0	100.000
1643	0.800	0.0	100.000
1849	0.900	0.0	100.000
2054	1.000	0.0	100.000
Values	1.000	0.0	100.000

Average = 0.01148

Geometric Average = 0.00867

Number of Values = 2948

Standard Deviation = 0.01103

Geometric Standard Deviation = 2.52901

Federal Standard = 100 $\mu g/m^3$ Annual Arithmetic Mean

Source: Environmental Research & Technology, Inc.

Table 321b

Hourly Average Nitrogen Dioxide -- Lynch Road Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
20	0.010	72.895%	72.895%
41	0.020	23.066	95.962
62	0.030	3.183	99.144
82	0.040	0.753	99.897
103	0.050	0.103	100.000
123	0.060	0.0	100.000
144	0.070	0.0	100.000
164	0.080	0.0	100.000
185	0.090	0.0	100.000
205	0.100	0.0	100.000
308	0.150	0.0	100.000
411	0.200	0.0	100.000
616	0.300	0.0	100.000
822	0.400	0.0	100.000
1077	0.500	0.0	100.000
1232	0.600	0.0	100.000
1438	0.700	0.0	100.000
1643	0.800	0.0	100.000
1849	0.900	0.0	100.000
2054	1.000	0.0	100.000
Values	1.000	0.0	100.000

Average = 0.00832

Geometric Average = 0.00677

Number of Values = 2922

Standard Deviation = 0.00595

Geometric Standard Deviation = 2.05910

Federal Standard = 100 $\mu g/m^3$ Annual Arithmetic Mean

Source: Environmental Research & Technology, Inc.

Table 2-322a

Hourly Average Ozone - Route 20 Site

Upper Limit of Interval µg/m³	ppm	Percent Occurrence	Cummulative Percent
4	0.002	7.019	7.019
8	0.004	3.451	10.470
12	0.006	4.359	14.829
16	0.008	2.660	17.488
20	0.010	3.243	20.732
24	0.012	2.880	23.612
28	0.014	3.101	26.712
32	0.016	3.191	29.904
36	0.018	3.918	33.822
40	0.020	3.944	37.766
61	0.030	19.785	57.551
81	0.040	16.606	74.157
121	0.060	17.138	91.295
160	0.080	6.201	97.496
202	0.100	1.751	99.247
242	0.120	0.584	99.831
283	0.140	0.143	99.974
323	0.160	0.026	100.000
363	0.180	0.0	100.000
404	0.200	0.0	100.000
Values	0.200	0.0	100.000

Average = 0.02954

Geometric Average = 0.02253

Number of Values = 7708

Standard Deviation = 0.02138

Geometric Standard Deviation = 2.49360

Federal Standard = 160 µg/m³

Table 2-322b

Hourly Average Ozone - Lynch Road Site

Upper Limit of Interval $\mu g/m^3$	ppm	Percent Occurrence	Cumulative Percent
4	0.002	8.674	8.674
2	0.004	2.587	11.261
12	0.006	2.358	13.619
16	0.008	2.538	16.157
20	0.010	2.310	18.467
24	0.012	3.020	21.487
28	0.014	2.659	24.146
32	0.016	3.068	27.214
36	0.018	3.597	30.811
40	0.020	3.657	34.468
61	0.030	20.982	55.450
81	0.040	17.962	73.412
121	0.060	17.505	90.917
160	0.080	5.787	96.703
202	0.100	2.466	99.170
242	0.120	0.590	99.759
283	0.140	0.217	99.976
323	0.160	0.024	100.000
363	0.180	0.0	100.000
404	0.200	0.0	100.000
Values	0.200	0.0	100.000

Average = 0.03057

Geometric Average = 0.02464

Number of Values = 8312

Standard Deviation = 0.02194

Geometric Standard Deviation = 2.39160

Federal Standard = 160 $\mu g/m^3$

Table 2-323a

TSP Analysis Summary - Route 20 Site
April 1977 - March 1978

Possible Number of Readings	352
Number of Good Values	293
Number of Missing Values	59
Data Capture (Percent)	83.24%
National Primary 12-Mo. Standard	75.
National Secondary 12-Mo. Standard	60.
State 12-Mo. Standard 1	60.
12-Month Geometric Mean	46.0
12-Month Geometric Sd. Deviation	1.8
National Primary 24 Hr. Standard	260.
Number of Excesses Occurred	0.
National Secondary 24 Hr. Standard	150.
Number of Excesses Occurred	2.
State 24 Hr. Standard 1	150.
Number of Excesses Occurred	2.

All values are in micrograms per cubic meter
State 12-Mo. Standard 1 is the OH
State 24-Hr. Standard 1 is the OH

Primary 12-Mo. Standard
Primary 24-Hr. Standard

Table 2-323b

TSP Analysis Summary - Lynch Road Site
April 1977 - March 1978

Possible Number of Readings	352
Number of Good Values	297
Number of Missing Values	55
Data Capture (Percent)	84.38%
National Primary 12-Mo. Standard	75.
National Secondary 12-Mo. Standard	60.
State 12-Mo. Standard 1	75.
State 12-Mo. Standard 2	60.
12-Month Geometric Mean	38.7
12-Month Geometric Sd. Deviation	1.8
National Primary 24-Hr. Standard	260.
Number of Excesses Occurred	0.
National Secondary 24-Hr. Standard	150.
Number of Excesses Occurred	0.
State 24-Hr. Standard 1	260.
Number of Excesses Occurred	0.
State 24-Hr. Standard 2	150.
Number of Excesses Occurred	0.

All values are in micrograms per cubic meter
State 12-Mo. Standard 1 is the PA
State 12-Mo. Standard 2 is the
State 24-Hr. Standard 1 is the PA
State 24-Hr. Standard 2 is the

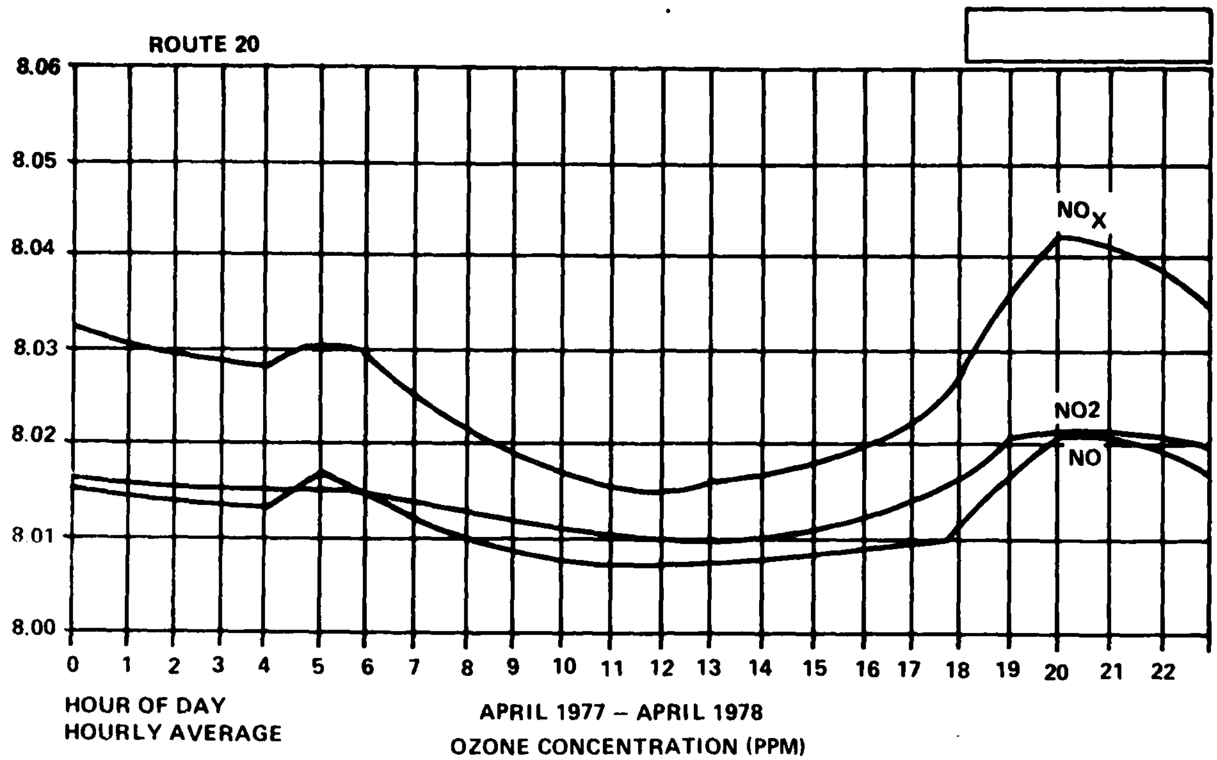
Primary 12-Mo. Standard
Secondary 12-Mo. Standard
Primary 24-Hr. Standard
Secondary 24-Hr. Standard

2-318d for the onsite monitors indicate lower levels for the period of record. Consequently, given the relatively constant seasonal variation, the amounts of sulfur dioxide emissions in the area, and an annual arithmetic mean of approximately 30 ug/m^3 for 1976 in Ashtabula County, it is highly improbable that the standard would be violated.

2.584
The incomplete combustion of the fuel used in motor vehicles account for most of the carbon monoxide and hydrocarbon emissions. Tables 2-319a through 2-319d show averages considerably below the standard for carbon monoxide. Table 2-320a shows that for nonmethane hydrocarbons 239 days of data collected were valid for the 6 to 9 a.m. time period at Lynch Road. Thirty-nine days of data were collected at the Route 20 site (Table 2-320b). These data indicate that the maximum 3-hour average standard (6-9 a.m.) of 160 ug/m^3 (.24 ppm) was exceeded twice at the Lynch Road site. Although the data are not complete enough to make specific estimates regarding the number of days in a year the standard value would be exceeded, the 6-9 a.m. average of 33 ug/m^3 (.05 ppm) indicates that the background level is normally much lower than the standard.

2.585
Nitrogen dioxide levels during the monitoring period were considerably lower than the national standard as shown in Figure 2-97. As noted previously, 63 counties within the State of Ohio have been determined to be a nonattainment area for ozone by the USEPA under Section 107 of the Clean Air Act. Data presented in Tables 2-322 and 2-322b indicate that national standard was exceeded 2.5 percent and 3.3 percent of the time, during the years' monitoring period. However, the ambient standard for ozone had recently been changed by the EPA after extensive analyses of data. The previous standard of 160 ug/m^3 has been increased to 240 ug/m^3. Examination of the data indicate that the new ozone standard has been exceeded 0.2 percent of the time at the two monitoring stations. Figure 2-98 also shows that the daily average maximum ozone concentration was 100 ug/m^3. During the period April through August, 1977, both the Lynch Road and Route 20 sites indicated a few total suspended particulate levels near or exceeding the 24-hour secondary standard of 150 ug/m^3 refer to Table 2-323a) whereas the monitor in Conneaut was below the standard. As a result, an investigation was performed to identify, the sources and reasons for the few days of high total suspended particulate (TSP) levels at the two monitor stations onsite. Particulates are emitted by a diverse group of sources, and vary over a wide range of sizes, shapes, densities, and chemical compositions. Consequently, a detailed analysis of different particulate samples can be used to determine probable sources.

2.586
Correlations between total suspended particulates, average wind



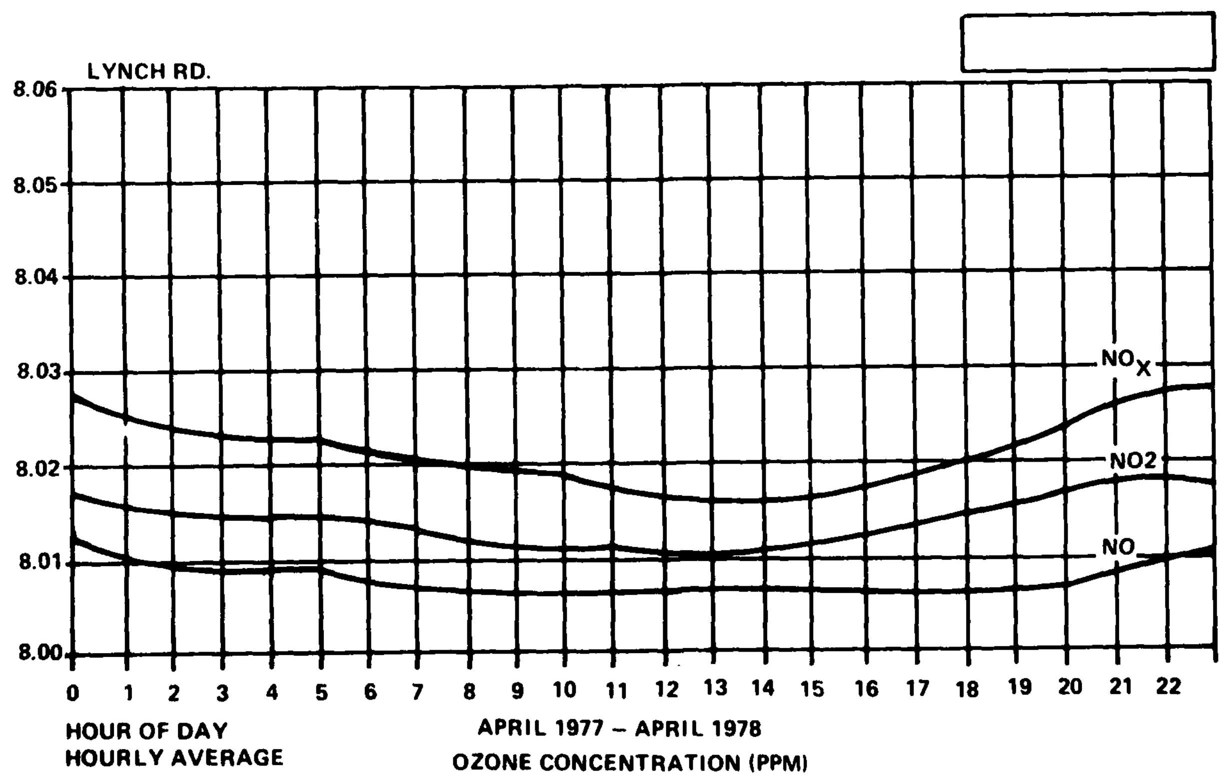
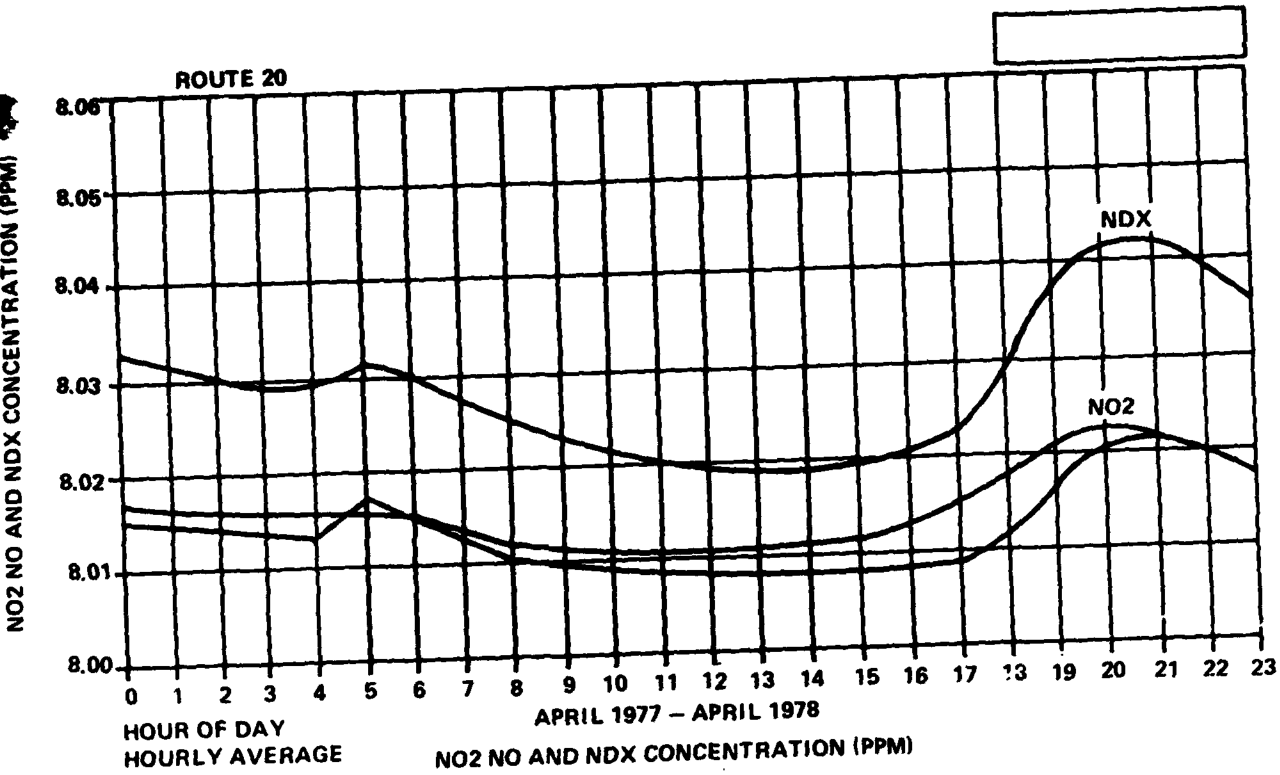


FIGURE 2-97 PLOTS OF DIURNAL OZONE CONCENTRATIONS AT THE TWO MONITOR SITES



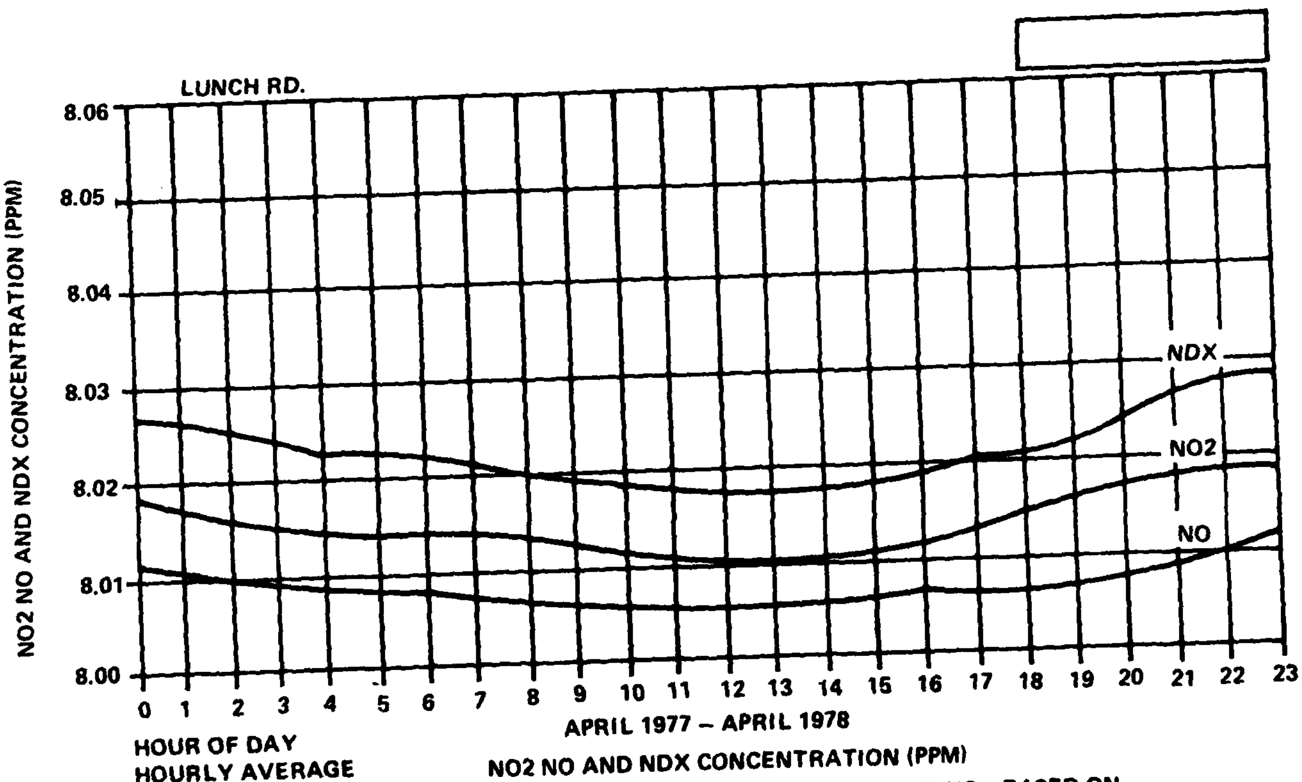


FIGURE 2-98 AVERAGE HOURLY AMBIENT CONCENTRATION PLOTS OF NO_X BASED ON ONE YEAR OF DATA

speed, and the percent of time the wind originated in each of 12 30° sectors were calculated; (refer to Table 2-324) differences were found to be significant at the 90 percent confidence level for the 240° - 270° and 270° - 300° sectors only. This indicates that the westerly wind transports particulates to the site from sources located near those sectors. The only major emissin source in the area is the Ashtabula power plant, approximately seven miles southwest. This power plant emits approximately 18,000 tonnes (19,800 tons) of particulates per year based on the Ohio EPA inventory for Ashtabula County. To test the assumption that the power plant emissions are the principal cause of the site particulate levels, filter samples corresponding to both high and low levels were characterized by X-ray diffraction analysis. The analysis determined mineral components and relative amounts, by low and high (50x and 500x, respectively), optical microscopy, scanning electron microscopy and weight loss after combustion. Samples, representing days with the high TSP levels, were taken on 19 April and 22 June 1977. Examination of the "Daily Progress Report" of work for the Local Storage Expansion Project of the Bessemer & Lake Erie Railroad indicated that 22 June represented a day of considerable dust generating activity, i.e., dirt road travel and fine grading near the Route 20 monitoring site. For this day, the TSP level at the Route 20 site was almost three times greater than the level at the more distant Lynch Road site. On the other hand, the 19 April sample represented a day on which both monitoring stations recorded high TSP levels. Examination of the low magnification photographs showed a similar size distribution for the two samples; however, the 19 April samples contained more spherical particles, similar to flyash, whereas the 22 June sample contained mostly isotropic, chunky particles as would be expected for inorganic minerals. At high magnification, the 19 April sample was observed to contain a considerable amount of fine, submicron particulate, which was determined to be unburned carbon (soot).

2.587
The hourly average concentrations of other pollutants along with the hourly average wind directions from the Perry's Bluff station were plotted for the 19 April. The series of hourly plots at both monitoring stations for ozone, nitrogen dioxide, and sulfur dioxide along with the wind direction are given in Figure 2-99. It should be noted that the usual early afternoon rise in ambient ozone concentration occurs. However, during the midafternoon, there is a wind shift from the west and south with a decrease in ozone concentration along with corresponding increases in nitrogen dioxide and sulfur dioxide concentrations. The wind direction during this episode was from the direction of the Ashtabula Power Plant (southwest). Indication that this pollution episode is due to the power plant is verified by the NO_2 -ozone relationship. Nitrogen Oxide (NO) is produced in the high temperature combustion of a power house boiler. This NO is

Table 2-324

Correlation Coefficients -- Conneaut Monitor

	TSP	Wind Speed	Wind Direction 0 30	30 60	60 90	90 120	120 150	150 180	180 210	210 240	240 270	270 300	300 330	330 360
TSP >100 $\mu g/m^3$	1.000	0.26	-0.61	0.00	-0.77	-0.36	0.00	-0.18	0.10	-0.26	0.46	0.85	0.27	-0.71
Wind Speed	0.26	1.00	-0.43	0.00	-0.25	-0.50	0.00	-0.82	0.75	0.00	0.97	0.72	-0.59	-0.35
TSP <100 $\mu g/m^3$	1.00	-0.69	-0.09	-0.40	-0.40	0.00	0.21	0.46	0.30	0.50	0.13	0.20	-0.83	-0.44
Wind Speed	-0.69	1.00	0.28	0.67	0.67	0.00	-0.04	-0.54	-0.33	-0.08	0.02	-0.76	0.40	0.27

Source: Arthur D. Little, Inc.

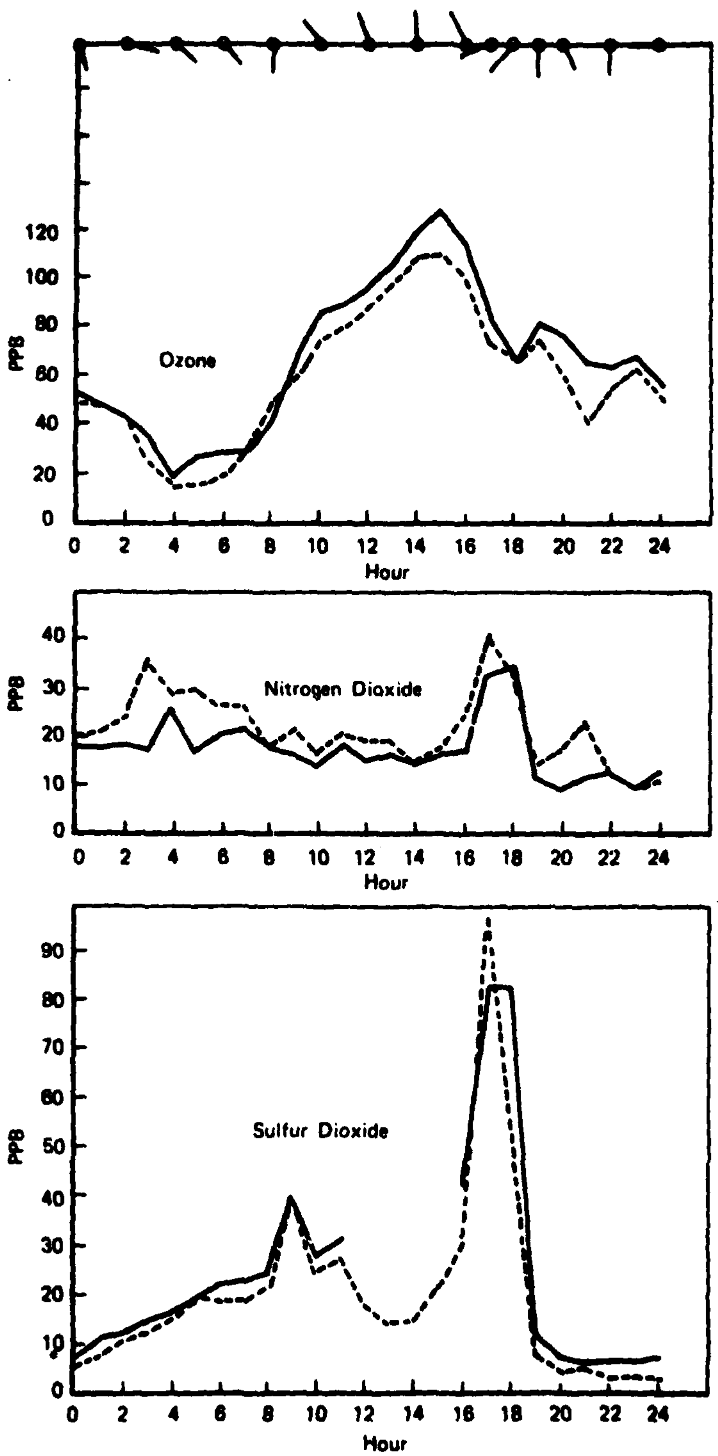


FIGURE 2-99 HOURLY PLOTS OF OZONE, NITROGEN OXIDE, SULFUR DIOXIDE, AND WIND DIRECTION

readily oxidized by the ozone in the ambient air to NO_2. The reaction results in an increase in nitrogen dioxide concentrations with a decrease in ozone. This phenomenon has been observed previously and is analyzed in a recent paper entitled, "On the Depletion of Ambient Ozone by a Rural Coal-Fired Power Plant Near Portage, Wisconsin" by Brown and Stearns. (2-148) The hourly sulfur dioxide concentration at both stations rapidly increase during this interval. The sulfur dioxide concentration can therefore be assumed to be due to the Ashtabula Power Plant. On this day, the 24-hour average sulfur dioxide concentration at one of the monitors was 65 ug/m^3, practically all of which was due to the Ashtabula plant. During normal operations, this plant emits more than 60,000 tonnes (66,000 tons) of sulfur dioxide per year. This emission rate is approximately four times as great as the particulate emission rate. Based on the particulate to sulfur dioxide emission ratio, it can therefore be assumed that the 65 ug/m^3 sulfur dioxide concentration would correspond to 15 to 20 ug/m^3 of particulates from the power plant. However, the power plant is subject to a compliance order to reduce particulate emissions by 90 percent by 1981. The contribution of this plant under 19 April meteorological conditions would thus be 1 to 2 ug/m^3n rather than the estimated 15 to 20 after 1981 as described above.

2.588
On 19 April, the Conneaut monitor station recorded a high for the year of 138 ug/m^3 still somewhat lower than the two onsite values of 169 and 150 ug/m^3 although levels at all three sites were higher on this day due to the significant contributions from the power plant, an additional amount of particulates for the onsite samples would be due to localized dust sources which did not affect the Conneaut site. This additional particulate loading would be attributed to dust generated during construction of the Bessemer & Lake Erie rail yard, a land clearing and grading area in the near vicinity of the monitors. This area is approximately 300 meters by 1,500 meters in area and has been the subject of heavy construction activity during the spring. Attempts at quantifying the impact of the construction site on the monitors for selected days based on the sample analyses have led to concentration ranges of 10-20 ug/m^3 for a 24-hour sample. The 19 April sample showed the presence of a large contribution from the Ashtabula power Plant along with contributions from the construction site. The cumulative effect of these two major particulate sources on the hi-vol monitor at the U.S. Steel site can result in increasing the 24-hour TSP ambient concentration by as much as 40 ug/m^3. The 19 April sample showed the presence of a large amount of material that could be associated with a coal combustion source, whereas the 22 June sample appeared to be more impacted by mineral dust. It seems safe to conclude that the uncommonly high TSP values measured were due to either the construction

activities of the Bessemer & Lake Erie Railroad project or to emissions from the power plant located 11 kilometers to the southwest of the monitor sites. It should be noted, however, that the railroad construction activity and emissions from the Ashtabula power facility, which is subject to 90 percent greater controls by 1980, are both temporary major sources and consequently, particulate levels are expected to be lower than those presently recorded, or below the secondary standards.

2.589
The high TSP values previously discussed occured on days in April 1977, with high emission levels from temporary construction activities. Examination of the post-construction days indicates that the ambient levels decreased considerably. Tables 2-323a and b show that the annual geometric mean at each site was 46 and 39 ug/m^3 - both considerably below the secondary standard of 60 ug/m^3.

2.590
Since the State of Pennsylvania has a sulfate standard sulfate analyses were performed on the TSP samples. The results are presented in Table 2-325 for both sites. The daily average maximum 19 ug/m^3 is well within the standard of 30 ug/m^3. In addition, a 30-day standard of 10 ug/m^3 was not exceeded during the 15 days of sampling, with averages of less than 8 ug/m^3 for both sites.

2.591
Sampling and chemical analyses were performed to determine the background concentrations of Benzo (a) pyrene, BaP, at the proposed plant site. The majority of BaP and related compounds in our environment is derived from incomplete combustion of organic matter. This mechanism can be responsible for the release of BaP to the atmosphere during coking operations. BaP exists as a particulate under ambient conditions, so the usual procedure is to determine BaP in TSP samples collected on glass fiber filters using high volume air samples. Twenty-nine TSP samples collected over the period 14 April to 30 June at the air quality monitoring stations were subsequently analyzed for BaP. The results of these analyses are shown in Table 2-326. Concentrations of BaP ranged from 0.04 to 1.5 nanograms/cubic meter (ng/m^3), with an overall arithmetic average for the two sites of 0.39 ng/m^3. Concentrations at other locations taken from the literature are shown in Table 2-327. (2-150-151) Most of the concentration values at the proposed plant site lie between the range of values shown in Table 2-327 for nonurban and urban areas.

Table 2-325

Sulfate Concentrations at the Proposed Site

Date	Route 20 Station ($\mu g\ SO_4^=/m^3$)	Lynch Road Station ($\mu g\ SO_4^=/m^3$)
4/14/77	6.8	8.0
4/18/77	15.0	16.5
4/22/77	14.9	18.8
4/26/77	5.7	8.1
5/01/77	7.0	8.7
5/07/77	<LDL (1)	<LDL (1)
5/13/77	2.6	1.1
5/19/77	5.5	3.2
5/25/77	1.9 (2)	2.9
5/21/77	13.0	3.9
6/06/77	3.8	2.8
6/12/77	6.0	5.1
6/18/77	8.5	7.1
6/24/77	14.6	13.9
6/30/77	5.2	4.9
Average	7.9 ± 4.6	7.5 ± 5.4

(1) <LDL = 1.0 /m^3

(2) Sample data 5/27/77

Pennsylvania Standard: 24-hour average = 30 $\mu g/m^3$; 30-day average = 10 $\mu g/m^3$

Source: Environmental Research & Technology, Inc.

Table 2-326

Benzo(a) Pyrene Concentrations at the Proposed Plant Site

(Micrograms/Cubic Meter)

	Route 20 Station	Lynch Road Station
April 14, 1977	0.0008	0.00002
18	0.00004	0.0006
22	0.00005	0.00008
26	0.00007	0.00004
May 1	0.0005	0.0006
7	0.00007	0.00006
13	0.0003	0.0001
19	0.0002	0.00006
25	-	0.0001
27	0.0006	-
31	0.0007	0.0005
June 6	0.0002	0.0001
12	-	0.0001
18	0.0002	0.0004
24	0.0009	0.0013
30	0.0015	0.0008

Source: Arthur D. Little, Inc.

Table 2-327

Average Concentrations of Benzo(a) Pyrene

	μg BaP/m^3
U.S. urban sites -- 1966	0.0028 (1)
U.S. urban sites (maximums) -- 1966	0.0112 (1)
Cleveland (1 site) -- 1972	0.0006 (1)
Cleveland (maximums of 16 sites) -- 1972	0.0162 (1)
Non-urban site -- Arizona	0.00004 (2)
Oregon	0.00001 (2)

Source: (1) King, R.B., et al., J. Air Poll. Cont. Ass. 27(9), 867 (1977).

(2) Stern, A.C., ed, Air Pollution, 2nd edn., Academic Press, New York, 1968.

Ambient Noise Climate

2.592
In order to describe the existing noise climate in the project area, a series of noise measurements were made over a five-day period (Tuesday through Saturday) in June 1977. (2-152). This noise sampling survey not only provides a numerical evaluation of the noise levels but also provides a technical basis for assessing the possible impacts of the proposed action in the local community.

a) Noise Measure Scale

2.593
Noise levels are expressed in units of dBA, i.e., decibels on the A-weighted scale. The A-weighted noise levels are obtainable directly with a sound level meter incorporating an A-weighted spectral filter network. The A-weighting noise levels are commonly used in environmental noise studies because they have been found to be closely correlated with human perception of noisiness or annoyance. Some commonly experienced sound levels expressed in dBA are shown in Figure 2-100. Note that a 10 dBA increase in noise level has been found to correspond to a doubling in the perceived noisiness or subjective loudness. Commercially available noise measuring instruments, appropriate for field use, and which meet applicable standards are accurate to approximately ± 2 dBA. Thus, any field-measured noise levels cannot be considered more accurate than to the nearest one or two decibels. This accuracy is quite adequate since even under controlled, ideal laboratory conditions, people can barely perceive a change in noise level of one dBA. A difference of three dBA occurring over a period of more than a few minutes is thought by many acoustical specialists to represent a just noticeable difference. A five dBA difference is clearly noticeable, while a 10 dBA difference is a very significant difference as noted above.

2.594
Noise levels in Conneaut fluctuate during the day and night. In most urban locations, they are quieter at night than during the day when there is more activity. However, even over a period of a few minutes there are variations in noise level due to passing events. To take account of these fluctuations it is the usual practice to consider the statistical distribution of noise levels with time. The current methodology for describing the statistical characteristics of the community noise level fluctuations is in terms of the percent of exceedence. For example, if the noise level during a certain time period exceeds 65 dBA for 25 percent of the time (say, 15 minutes out of an hour) the exceedence for 65 dBA is stated to be 25 percent.

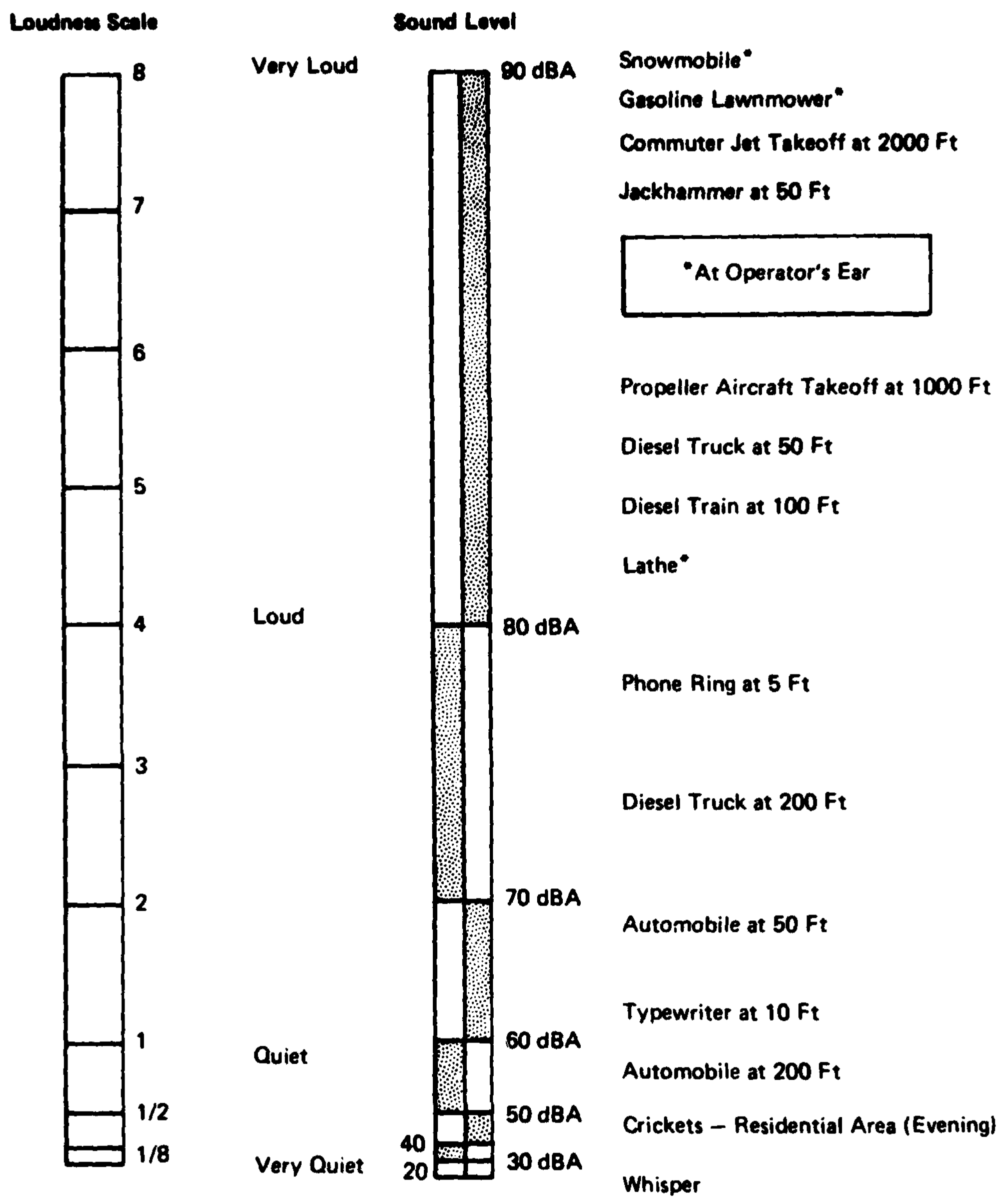


FIGURE 2–100 TYPICAL SOUND LEVELS IN dBA AND THEIR SUBJECTIVE LOUDNESS

Noise exceedence levels are denoted by L10, L50, L90, etc., where L10, for example, is the noise level exceeded 10 percent of the time. In addition to these statistical measures, the environmental noise can also be characterized by average levels, such as the energy equivalent continuous noise levels, LEQ, and by the day/night equivalent noise level, LDN. The latter measure incorporates a 10 dB penalty for nighttime noise between 10 p.m. and 7 a.m. to reflect the added likelihood of annoyance during this nighttime period. (2-153)

b) Noise Sampling Locations

2.595
A total of eight noise sampling locations were used. A brief description of each location and the associated dominant existing noise sources is presented in Table 2-328. The measurement locations are shown in Figure 2-101. In addition to characterizing the major noise sources as listed in Table 2-328, there were additional considerations in selecting the eight noise measuring locations. Location 1, at the northeast corner of the site property line, would be representative of much of the easternmost property boundary, is rural in nature, and near an established recreational area. Location 2 is similar to Location 1, but also includes the effects of train traffic and vehicular traffic on Route 5. Location 3 is at or near the possible alignment of the eastern access road to the site. Location 4 is the closest boundary location to the midpoint of the proposed facility, and as such, would be expected to provide an important measure of the projected plant noise impacts. Measurements at Location 4 also characterize the noise climate along most of Route 20 and as such quantify the noise levels experienced by the abutting property owners on both sides of the roadway. The Rowe School at Location 5 is probably the most sensitive noise receptor that exists in the area due both to its function and location on the site property line. This location probably is also typical of the residential area just south of Route 20, but beyond the influence of Route 20 traffic. Location 6 has a line of sight to the existing industrial facilities and thus is directly exposed to a major preexisting community noise source. Location 7, although somewhat removed from the dock area source, is representative of another noise-sensitive receptor nearest to the site property line. Location 8 is very rural in nature and typical of the sparsely populated area south of Conneaut. It is through this area that a possible western access road to Route 7 from the site may be built. The remaining possible access road alignment is directly to an interchange with I-90 located within the site boundaries.

Table 2-328

Sampling Locations and Associated Major Noise Sources

Location	Description	Major Noise Sources
1	Elmwood and Lake Rds, approx 12 m (40 ft) from edges of roads	Traffic on Elmwood and Lake Rds
2	Elmwood Rd. 11 m (35 ft) from edge of road and 120 m (400 ft) north of N&W RR track	Traffic on Elmwood Rd, trains
3	Rt 20 and Rt 6N, 15 m (50 ft) from edge of Rt 6N and 34 m (110 ft) from edge of Rt 20	Rt. 20 and Rt. 6N traffic
4	Rt 20, weighing station, 30 m (100 ft) from edge of roadway	Rt. 20 and I-90 traffic, trains
5	Rowe School, edge of athletic field: 25 m (80 ft) from School Bus Storage	Trains, maintenance garage
6	Parking lot of P.&C. Dock Co., at chain link fence	Dock Activities
7	Vacant lot, (Pearl & Day Sts) 7 m (20 ft) to edge of Pearl and 11 m (35 ft) to edge of Day	Dock Activities, local traffic
8	Dorman Rd, 6 m (20 ft) from edge of road, 300 m (1000 ft) from near lane of I-90	I-90 traffic

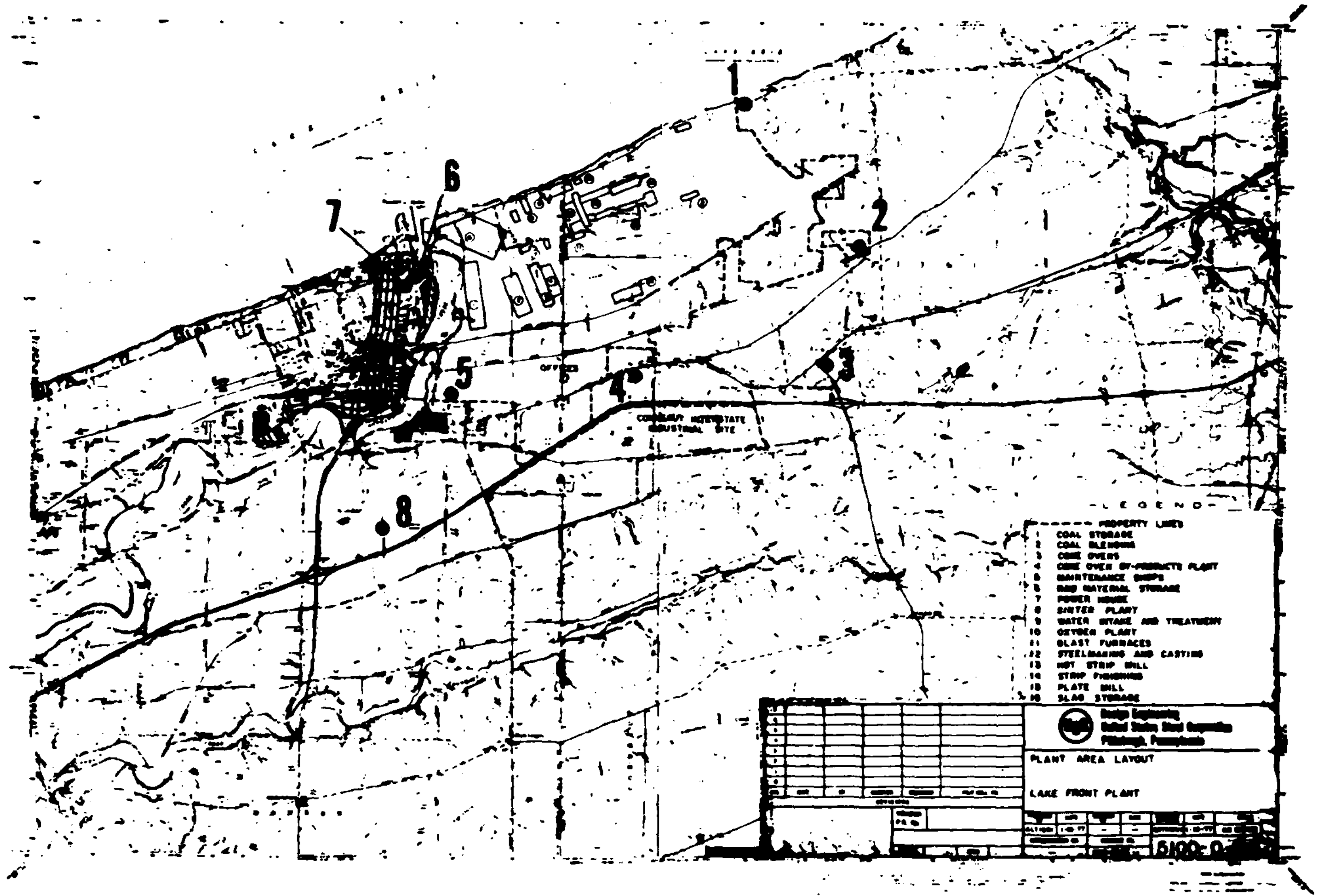


FIGURE 2–101 BASELINE NOISE MEASUREMENT LOCATIONS

c) Noise Sampling Schedule

2.596
Due to the size of the property owned by the U.S. Steel Corporation, it was necessary to use a detailed and carefully planned sampling schedule in order that both diurnal and day-to-day variations could be documented within a reasonable time period. The sampling plan which was adopted is shown in Figure 2-102. As indicated, measurements were taken mainly over a four-day period, with the majority of samples taken at Locations 4, 5, and 7. This was done in order that the diurnal variation in noise level could be defined at these three locations. The intensive sampling carried out on days two and three provided one sample every 90 minutes at each of these three locations over a 21-hour time period. Day-to-day variations were investigated by taking repeated measurements at Locations 4, 5, and 7 on each of four test days at the same time each day during the 2 to 5 p.m. period. This emphasis on Locations 4, 5, and 7 is due to the sensitivity of the receptors as described earlier. Less intense sampling was conducted at the other measurement locations. Four samples were taken at each of the Locations 1, 2, 3, 6, and 8. As shown on the test schedule, the four samples were collected during the morning, midday, evening, and nighttime hours at each of these five locations. By taking these samples at different time periods, it was possible to document in broad terms any variations in noise level with time of day at each of these five additional locations. No samples were taken at any of the eight locations during the 2-5 a.m. period in order to keep the effort within manageable limits. Thus, the diurnal variations at Locations 4, 5, and 7 were defined only over a 21 rather than full 24-hour period. A reasonably accurate estimate of noise levels from 2-5 a.m. can be obtained by interpolation since it is known that noise levels are relatively constant during this time period. (2-154)

d) Existing Noise Climate

Diurnal Variations at Locations 4, 5, and 7

2.597
As indicated on the test schedule of Figure 2-102, 20 samples were taken at Location 4. Of these 20 samples, 14 can be used to construct a graph showing the hour-to-hour, or diurnal, variation in the noise climate at this location. This diurnal variation graph for Location 4 is shown in Figure 2-103. Diurnal variation curves for Locations 5 and 7 are shown in Figures 2-104 and 2-105. The graphs shown in Figures 2-103 through 2-105 illustrate some salient features of the noise climate in the Conneaut area. For example, Location 4

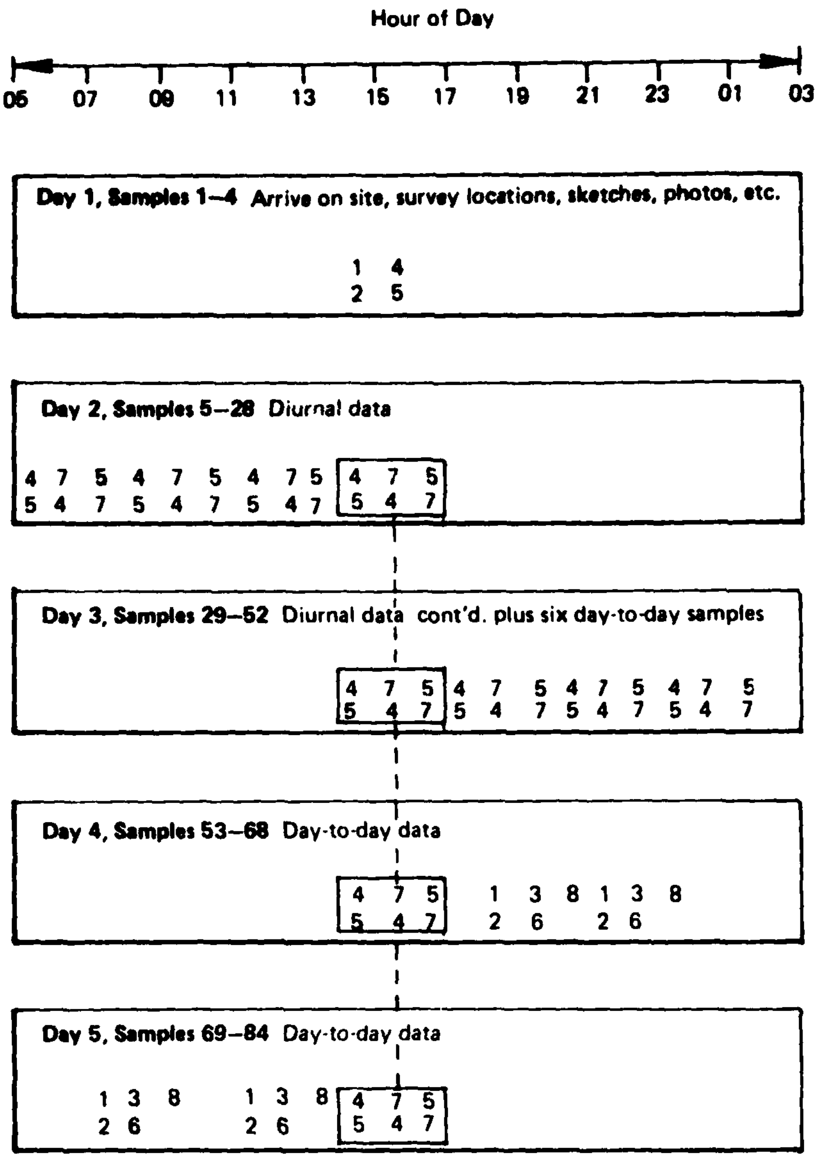


FIGURE 2–102 NOISE MEASUREMENT SCHEDULE – 5 DAYS, 8 LOCATIONS, 84 TOTAL SAMPLES

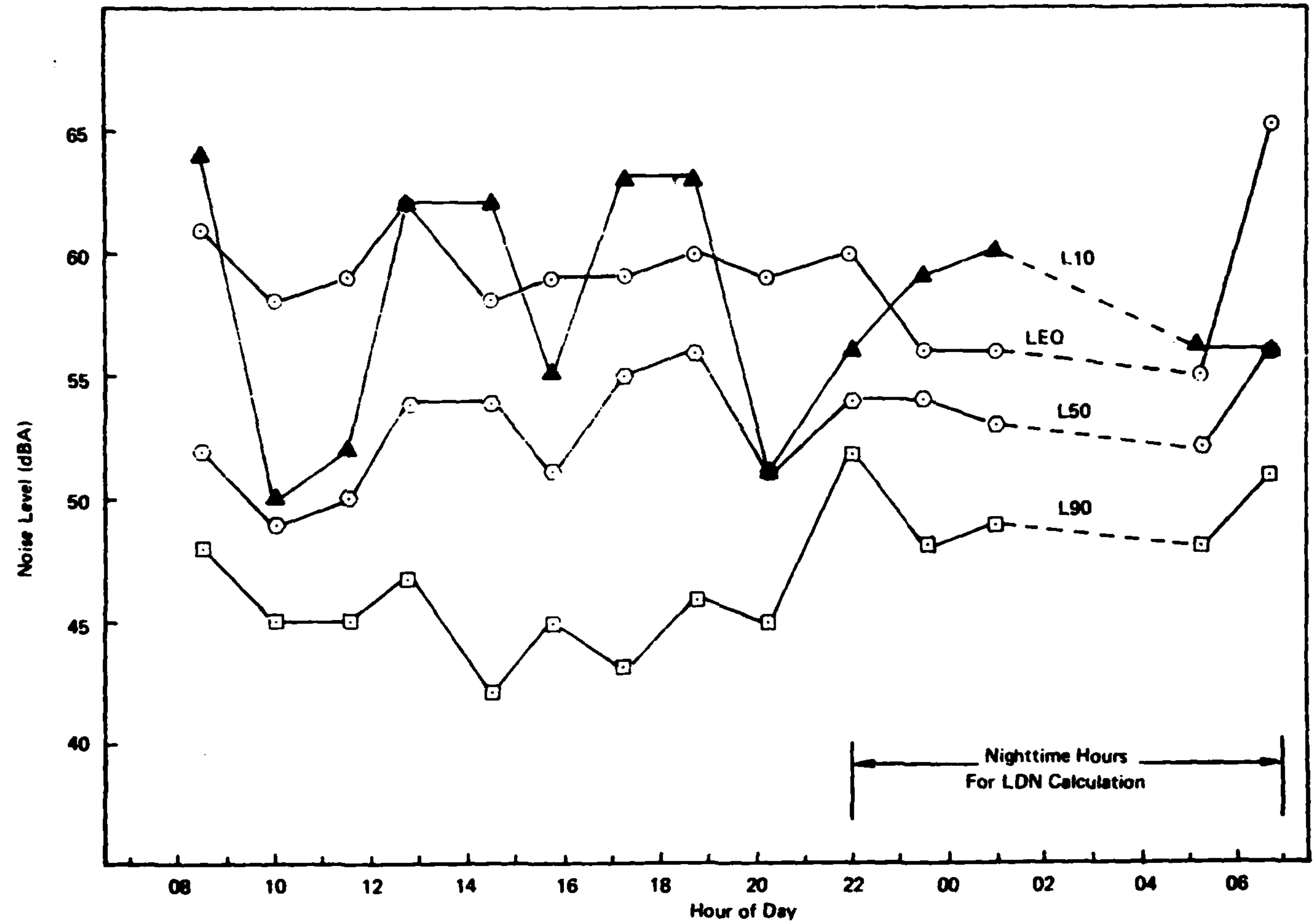


FIGURE 2–103 DIURNAL L90, L50, L10, AND LEQ NOISE LEVEL VARIATIONS AT LOCATION 4

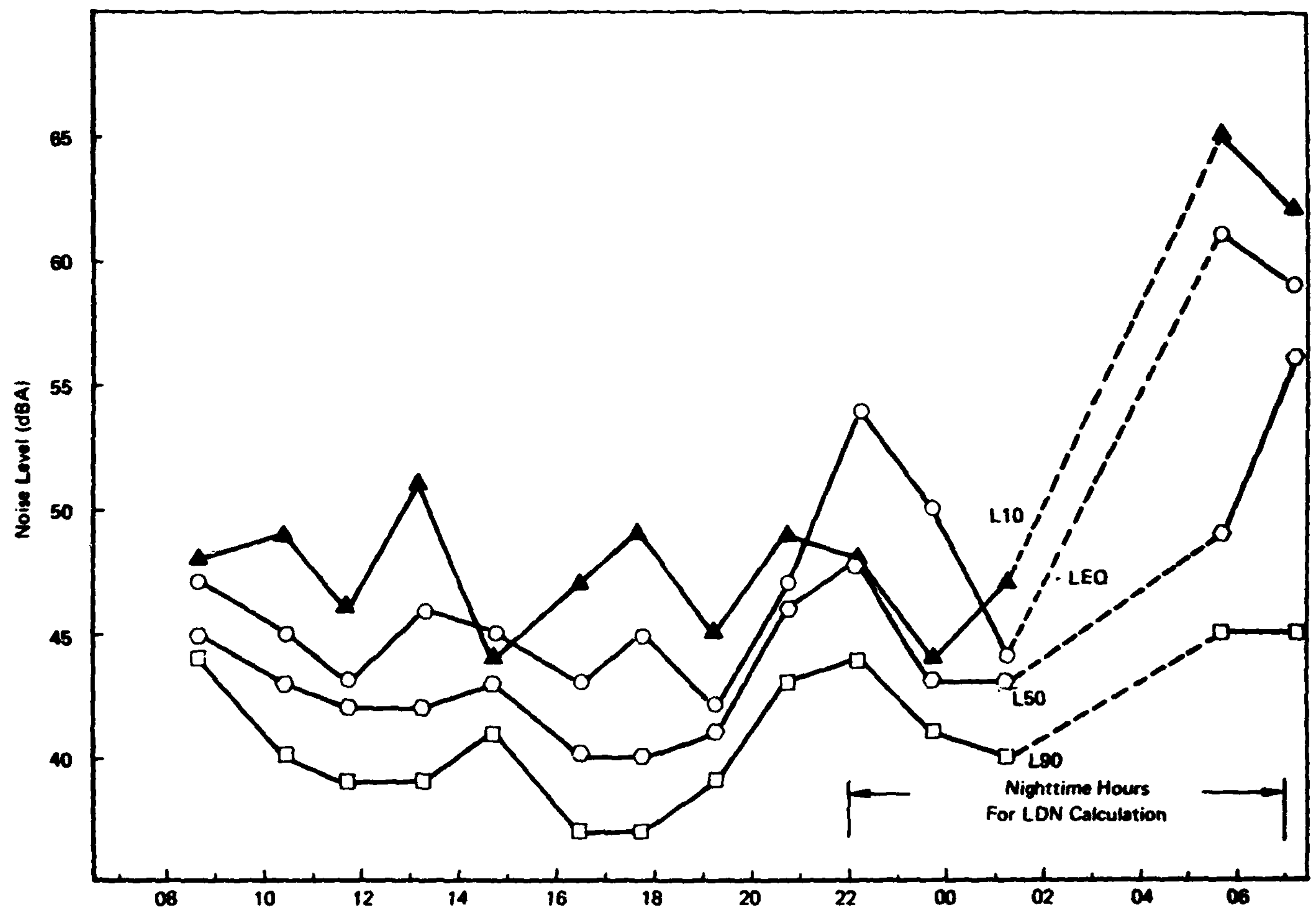


FIGURE 2–104 DIURNAL L90, L50, L10 AND LEQ NOISE LEVEL VARIATIONS AT LOCATION 5

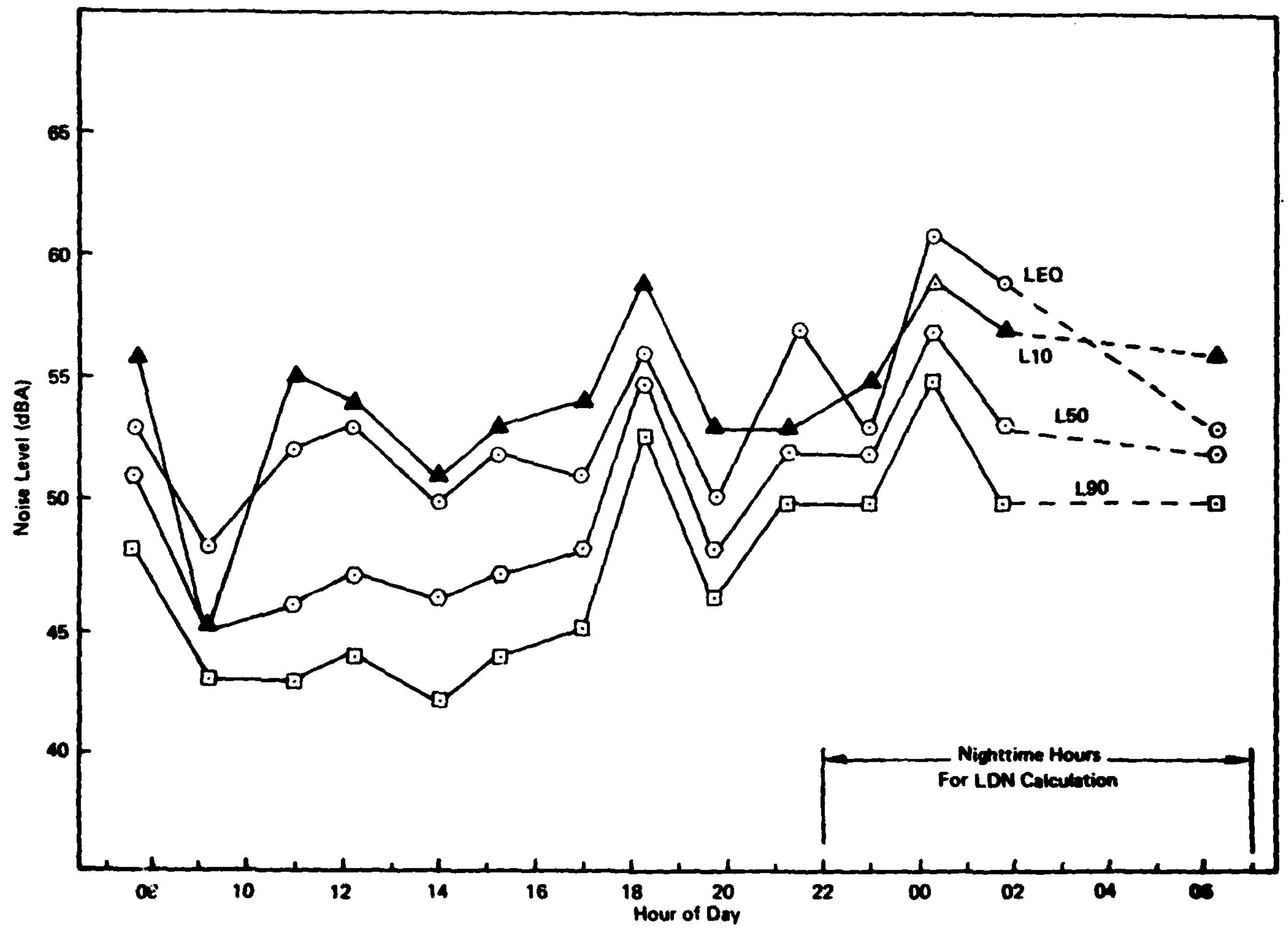


FIGURE 2–105 DIURNAL L90, L50, L10, AND LEQ NOISE LEVEL VARIATIONS AT LOCATION 7

is dominated by traffic on Route 20. This conclusion is supported by the L10 levels of Figure 2-104 which show peaks during the morning and evening rush hours together with relatively high midday levels. The microphone at this location was situated 30 meters (100 feet) from the edge of the roadway which was the approximate set-back of most of the residences along this section of Route 20. Note that even at this relatively short distance to the roadway, the L10 levels do not exceed the 70-dBA criteria of the Federal Highway Administration (FHWA). (2-155) The Location 5 diurnal variation graph of Figure 2-104 shows a quieter noise climate at this location. The 5:45 a.m. sample with the 65-dBA L10 level was primarily due to a passing train, and the 7:05 a.m. sample exhibiting the 62-dBA L10 was controlled by buses being started and idled in the maintenance yard at a distance of about 150 feet from the microphone. Other than these two early morning samples, the noise levels are low throughout the entire observation period. Also, it must be noted that school was not in session. However, when it is in session, significant increases in all of the daytime levels would be expected to occur. The data of Figure 2-104, however, does fairly state the present noise climate imposed upon the area of Location 5.

Diurnal Variation at Locations 1, 2, 3, 6, and 8

2.598
As indicated on the test schedule of Figure 2-102, Locations 1, 2, 3, 6, and 8 were each sampled during the morning, midday, evening, and nighttime periods. The four-point diurnal variation curves for these five locations are shown in Figure 2-106. These levels versus time graphs do not follow a normal suburban community characteristic of morning high and evening and nighttime lows. That is, all five curves in Figure 2-106 suggest that noise sources not typical of suburban areas influence the measured noise levels throughout the entire 24 hours. At Location 6 this exceptional noise source is the adjacent industrial facilities. Principle noise sources at Location 3 are the traffic along Route 20 and Route 6N. Location 8 is dominated by noise from I-90, particularly by trucks. Locations 1 and 2 both had LEQ levels of about 50 dBA which would be typical for these rural sites, but trains passing raised the LEQ levels significantly during several of the sampling periods.

Day to Day Variations

2.599
An important characteristic of the community noise climate at any location is the manner in which the noise levels change from day to day. To define this characteristic, repeated measurements were taken

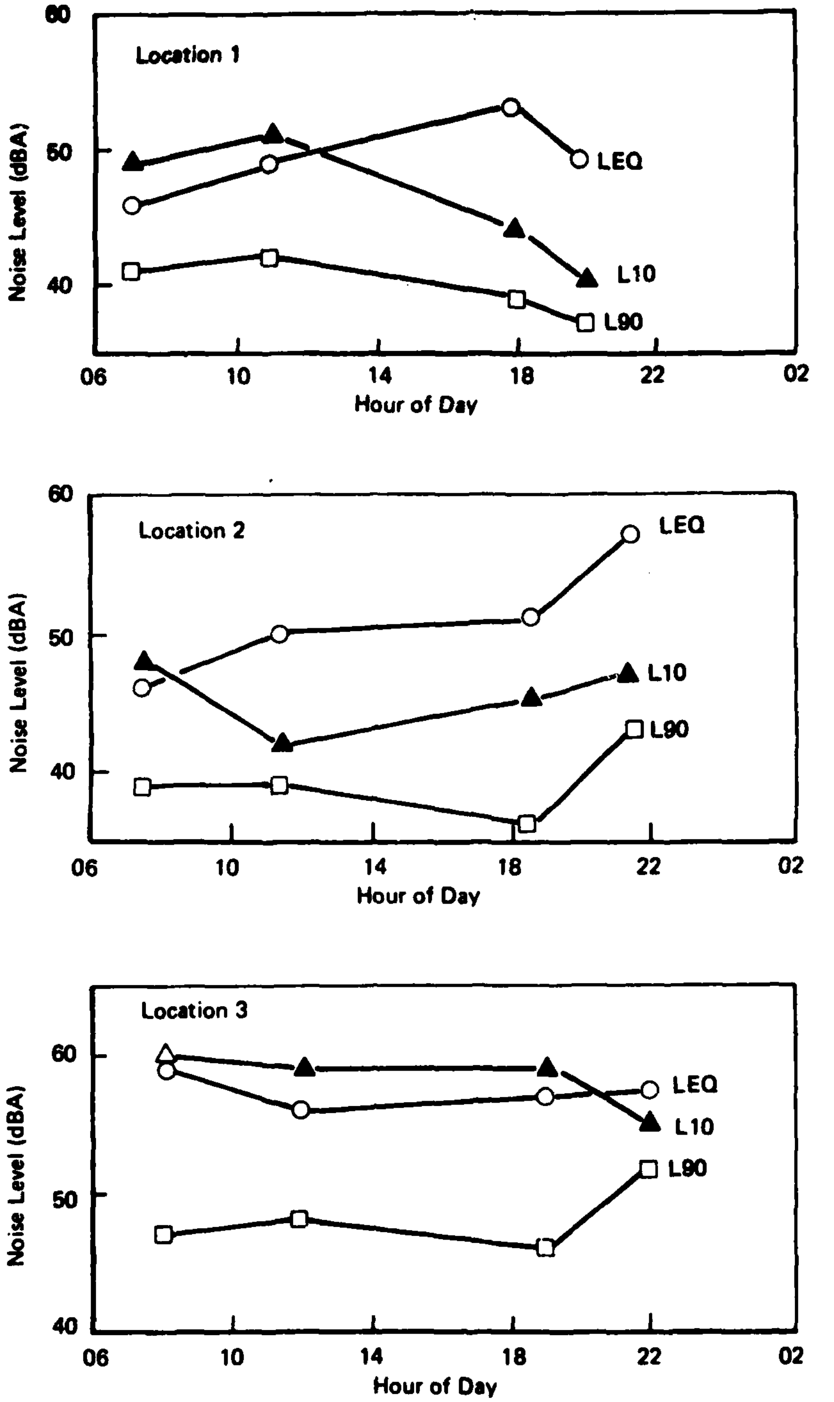
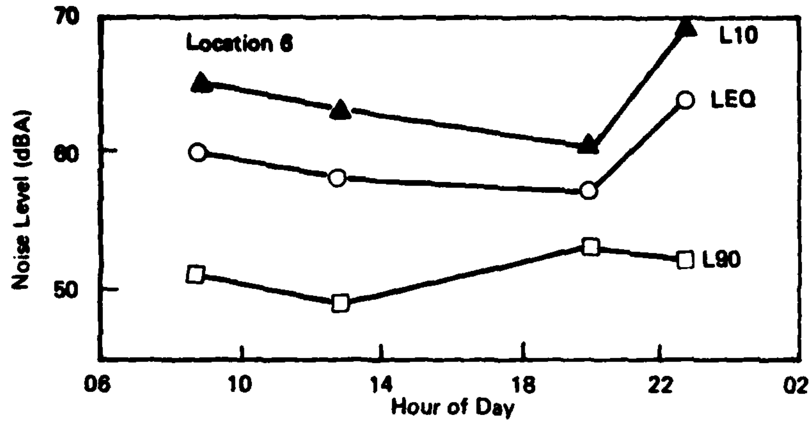


FIGURE 2–106 TIME OF DAY VARIATIONS IN L10, L90, AND LEQ NOISE LEVEL VARIATIONS AT LOCATIONS 1, 2, 3, 6, AND 8



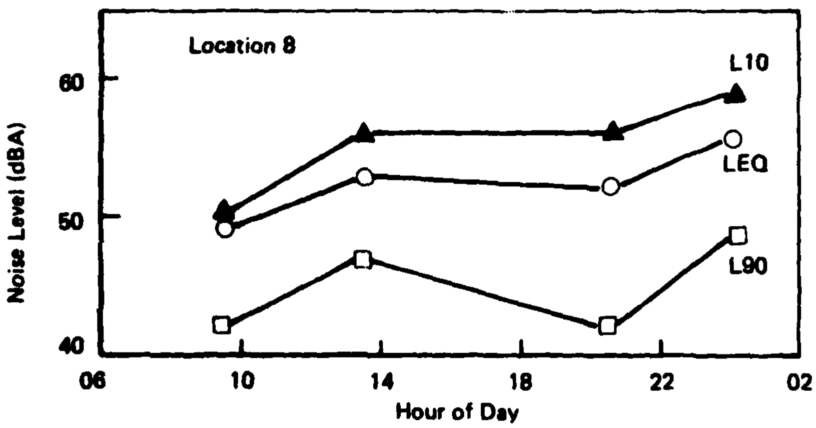


FIGURE 2–106 (Continued)

at Location 4, 5, and 7 at the same times on four different test days. Two samples were taken at each location (approximately 90 minutes apart) on each of the four test days. To estimate the day-to-day variation in noise level, the average of these two daily samples has been plotted versus test-day for each location as shown in Figure 2-107. The statistics of the repeated afternoon LEQ and L10 noise levels are summarized in Table 2-329. The ranges in noise level variation indicate a fairly stable day-to-day noise climate at each of the three locations tested. It can be expected that the 24-hour LEQ levels exhibit less variation than a two-hour LEQ reading, hence it can be concluded that the LEQ (24) and LDN levels at these locations are also quite stable from day to day. From the graphs of Figure 2-107 it can be seen that the Saturday, or day five, levels are comparable to the week day levels. This of course is an important conclusion in terms of predicting possible impacts from the 24-hour seven-days-a-week operation of the proposed plant.

LEQ (24) and LDN Levels.

2.600
Twenty-four-hour equivalent energy levels, i.e., LEQ (24), and associated day-night equivalent (LDN) levels have been calculated for each of the measurement locations. In the case of Locations 4, 5, and 7 these 24-hour levels were calculated directly from the LEQ levels plotted in Figures 2-103 through 2-105. The 2-5 a.m. time period during which no measurements were taken was accounted for by interpolation. In the case of Locations 1, 2, 3, 6, and 8, which were sampled only at four times throughout the 24-hour period, the calculations were carried out assuming three daytime samples and one nighttime sample. The results of these calculations are summarized in Table 2-330. Also included in this table are the average L10 levels.

e) Existing Community Sources and Land Uses

2.601
The results given in Table 2-330 characterize the general noise climate in Conneaut. One significant feature of this climate illustrated in the table is that the nighttime (10 p.m. to 7 a.m.) noise levels are slightly higher (by about 3-dBA) than the daytime levels. This rather unusual trend can be attributed to the frequency of occurrence during the 24-hour period of the various extraneous noise sources (trains, Route 20, I-90, and the dock facility) which influence the individual noise levels. The 24-hour composite noise levels given by LEQ(24) and LDN are moderate to relatively high, 50 to 70-dBA, for the various land uses at each measurement location.

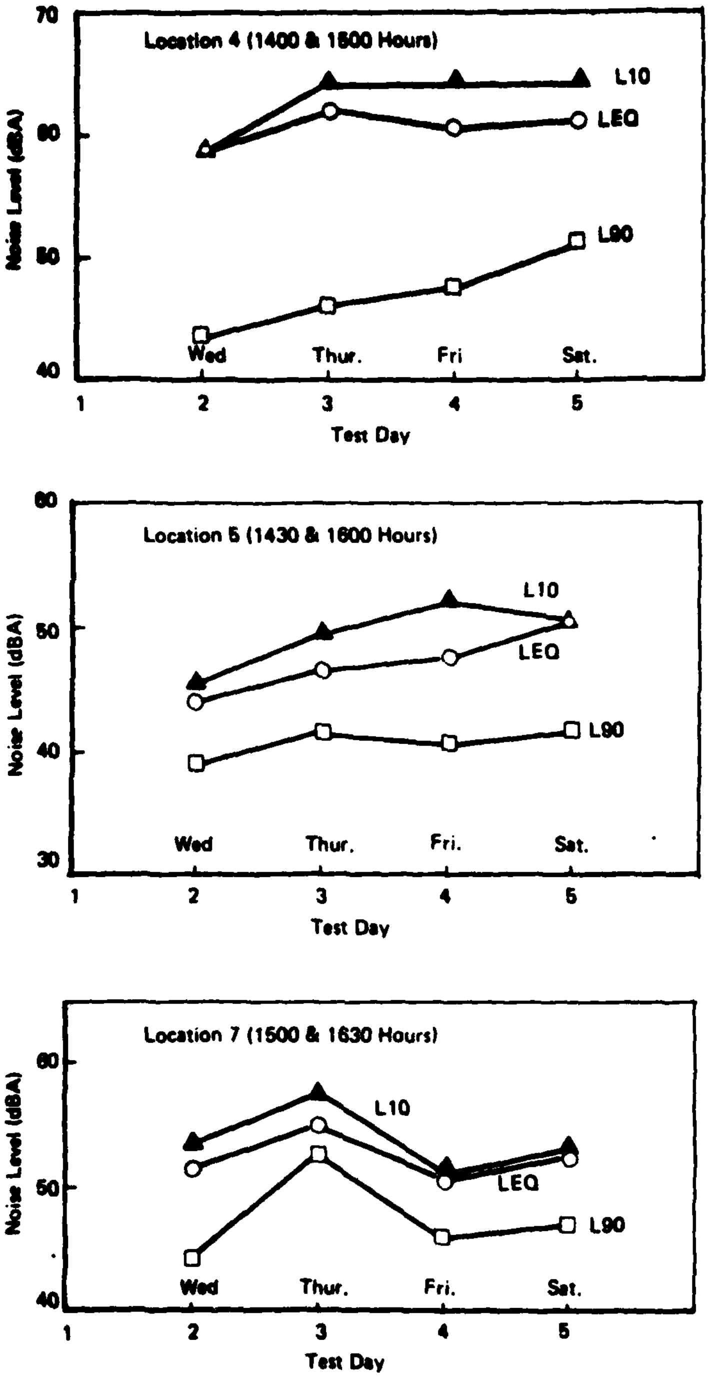


FIGURE 2–107 DAY-TO-DAY VARIATIONS IN LEQ, L90, AND L10 AT LOCAT[illegible] 4, 5, AND 7

Table 2-329

Summary of Repeated Afternoon Noise Levels in dBA[1]

Location	Average LEQ	Range	Average L10	Range
4	61	4	63	6
5	47	7	49	7
7	52	5	54	7

(1) See Figure 2-107.

Table 2-330

Noise Climate Summary for L10[1], LEQ, and LDN in dBA

	Daytime		Nighttime[2]		24-Hour	
Location	L10	LEQ	L10	LEQ	LEQ	LDN
1	46	50	49	49	50	56
2	46	50	-	57	54	53
3	59	57	55	57	57	64
4	60	60	58	59	60	66
5	50	50	51	57	54	63
6	63	58	69	64	61	70
7	54	53	57	58	56	64
8	54	51	59	56	54	62

(1) L10's in this table are arithmetic averages of applicable samples of L10's.
(2) "Nighttime" refers to the hours between 10 p.m. and 7 a.m.

These relatively high levels can be attributed to the following factors:

(1) Location 1, LDN = 56 dBA, LEQ(24) = 50 dBA
This location exhibits the lowest LEQ(24) and LDN levels of the eight locations sampled. This location is close to Raccoon Park and should be classified as a rural or quiet recreational land category. Train noise was audible at this site, and this noise, together with occasional local traffic dominated the hourly LEQ readings obtained here.

(2) Location 2, LDN = 63 dBA, LEQ(24) = 54 dBA
This location was in a rural, agricultural setting but only 120 meters (400 feet) from the N & W railroad tracks. Train passings were the major noise source; and since trains were heard during the nighttime hours, the LDN exceeds the LEQ(24) level by approximately 10 dBA.

(3) Location 3, LDN = 64 dBA, LEQ(24) = 57 dBA
Local traffic on Routes 20 and 6N controlled the noise levels at this residential location (Note: Figure 2-106 shows that the hourly LEQ values are essentially constant throughout the day and night. This trend is supported by the three traffic counts which were taken at this location, the results of which are summarized in Table 2-331.) In addition I-90 traffic was audible at this location during the 10 p.m. sample.

(4) This location is representative of the residential-light commercial receptors along Route 20. Route 20 traffic is the major source of noise at this location.

(5) This location was on the athletic field of the Conneaut Rowe Jr. High School and is thus a noise sensitive receptor. Measurements were taken when the school was not in session although school-related activities (band practice, tennis court play, and janitorial work) were noted. The major sources of noise however, were nearby trains and the bus maintenance garage. Note: Figure 2-104 shows that the two highest hourly LEQ readings were 61 and 59 dBA and were caused by a passing train and idling buses, respectively. Both of these events took place during the nighttime (10 p.m. - 7 a.m) hours and thus the LDN level at this location exceeds the LEQ(24) level by 9 dBA.

Table 2-331

Hourly Traffic Volumes at Location 3:

Routes 20 and 6N Combined(1)

Hour of Day	Autos	Pickups	Motorcycles	Trucks	Total
8-9 a.m.	159	0	0	9	168
Noon-1 p.m.	324	90	6	0	420
7-8 p.m.	618	138	24	12	792

(1) Based on manual counts of 5 to 15 minutes' duration.

(6) Location 6, LDN = 70 dBA, LEQ(24) = 61 dBA
This location was in the parking lot of the viewing area overlooking the industrial facilities and as such, is classified as industrial. The recorded LDN and LEQ(24) levels are therefore reasonable.

(7) Location 7, LDN = 64 dBA, LDQ(24) = dBA
Location 7, while right around the corner from Location 6, was in a residential area. The noise levels here were controlled almost completely by nearby industrial facilities.

(8) Location 8, LDN = 62 dBA, LDQ(24) = dBA
This Dorman Road location was in a rural agricultural setting. The noise climate was quiet except for the noise from I-90, 300 meters (1,000 feet) to the south.

The reported measurements and the above discussions yield a comprehensive definition of the existing noise climate in the community surrounding the proposed facility site.

2.602
In summary, the following observations can be made: The noise climate throughout the community does not follow a typical suburban community diurnal pattern of noisy rush hours and quiet nighttime periods. Noise levels at all measurement locations sampled were essentially constant throughout the 24-hour day; The day-to-day variation in noise level is not significant; i.e., the daily composite noise level from those taken on a Saturday show no significant change in noise level from those measured during regular week days; Extraneous noise sources dominate the community noise climate. Train traffic is probably the major extraneous source with I-90, Route 20, and the coal loading facility also contributing to the noise levels both day and night; despite the "rural" visual appearance of the area, the residents are exposed to those extraneous noise sources which, overall, make the acoustic climate one that is characterized as "noisy urban residential." (2-153) However, Location 6 is the exception since this area can be characterized as industrial.

2.603
To place the measured levels shown in Table 2-330 in perspective, they can be compared to "criteria" or "design levels" developed by the USEPA and FHWA. The EPA has identified levels as requisite to protect public health and welfare with an adequate margin of safety. These levels, which are not to be considered as standards since cost and feasibility were not taken into account were determined by considering such items as workplace noise levels, and

requirement to protect virtually the entire population from hearing loss, annoyance, activity interference and to establi h an "adequate margin of safety" taken as five dB. The levels identified in this manner are shown in Table 2-332. Due to the approach used in the determination, these levels are considered to be conservative. From the efforts undertaken by the FHWA toward the assessment and abatement of highway traffic noise, a set of noise "design levels" has evolved (2-155). The FWHA states in part that:

> "The design noise levels (in Table 2-333) represent a balancing of that which may be desirable and that which may be achievable. Consequently, noise impacts can occur even though the design noise levels are achieved. The design noise levels for Categories A, B, C, and E should be viewed as maximum values, recognizing that in many cases, the achievement of lower noise levels would result in even greater benefits to the community."

The design levels were based on a consideration of annoyance of disturbance and interference with speech communications.

2.604

Although the levels determined by the EPA and the FHWA have been based on somewhat different criteria, the levels are not necessarily incompatible. The FHWA levels of Table 2-333 are hourly values based on either the average of the highest three hours of an average day or some other justifiable critical time period. An hourly time period was selected by the FHWA with the knowledge that, in general, traffic noises do exhibit a few daytime peaks of an hour or so duration that are greater than other times especially at night. In contrast, the EPA identified levels apply to the entire day, either in the form of equivalent noise levels, LEQ, or day-night average noise levels, LDN. Comparing the noise climate of the project area as summarized in Table 2-330 with the EPA levels of Table 2-332, it is apparent that only Location 1 could be considered as satisfying the LDN 55 dBA criterion and half of the locations exceed the LEQ dBA criterion. With regard to the FHWA activity categories of Table 2-333, the following comparisons can be made. Location 1, which characterizes the park area directly east of the project site, represents a land use that fits within the definition of Activity Category A. Location 2, Location 5 at the Rowe School, Location 7 with Conneaut, and Location 8 south of Conneaut are considered as Activity Category B. Location 6, because it is an industrial area, is within the Activity Category C. The remaining locations, 3 and 4, represent a mixed land use of residences and commercial establishments which should place

Table 2-332

Summary of Noise Levels Identified as Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety

Effect	Level	Area
Hearing Loss	LEQ(24) $\leq$ 70 dB	All areas
Outdoor activity interference and annoyance	LDN $\leq$ 55 dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use
	LEQ(24) $\leq$ 55 dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	LDN $\leq$ 45 dB	Indoor residential areas
	LEQ(24) $\leq$ 45 dB	Other indoor areas with human activities such as schools, etc.

Source: "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," EPA 550/9-74-004, March 1974.

Table 2-333

Design Noise Level/Activity Relationships[1]

Activity Category	Design Noise Levels - dBA[2] LEQ(h)	L10(h)	Description of Activity Category
A[3]	57 (Exterior)	60 (Exterior)	Tracks of land in which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks or portions of parks, open spaces, or historic districts which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B[3]	67 (Exterior)	70 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, and parks which are not included in Category A and residences, motels, hotels, public meeting rooms, schools, churches, libraries, and hospitals.
C	72 (Exterior)	75 (Exterior)	Developed lands, properties or activities not included in Categories A or B above.
D	--	--	For requirements on undeveloped lands see paragraphs 11a and c.
E[4]	52 (Interior)	55 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

(1) See Paragraph 8 for method of application.
(2) Either L10 or LEQ (but not both) design noise levels may be used on a project.
(3) Parks in Categories A and B include all such lands (public or private which are actually used as parks as well as those public lands officially set aside or designated by a governmental agency as parks on the date of public knowledge of the proposed highway project.
(4) See Paragraphs 8c, d, and e for method of application.

Source: "Federal-Aid Highway Program Manual", Volume 7, Chapter 7, Section 3, U.S. Department of Transportation, May 14, 1976.

them in Category C. Comparing the noise level data from Figures 2-103 through 2-107 with the criteria of Table 2-333, shows that on the basis of either the L10 or LEQ measured levels, all of the site locations are below the design noise levels of their respective activity category. At Location 7, in Conneaut, the source of the L10 or LEQ levels is not traffic but rather the port operations. Consequently, the FHWA criteria cannot be applied to this location.

Hydrologic Regime

Limits of Analysis

2.605
The geographic scope of the baseline hydrologic data presented in this statement is limited to the Lake Erie Central Basin and the 10 principle tributary watersheds associated with it, Conneaut Creek, Turkey Creek, Raccoon Creek and the nearshore zone of Lake Erie in the vicinity of the Lakefront Plant site.

Surface Water

a) Location of Surface Water Resources

2.606
The dominant waterbody adjacent to the proposed site and the Regional Study area is Lake Erie. Within the Regional Study area itself the major watersheds draining into Lake Erie include those of the Cuyahoga River, Chagrin River, Grand River, Ashtabula Creek, Conneaut Creek, and Elk Creek. Their basins extend inland from the lake shoreline about 10-40 miles. The French Creek watershed also lies within the limits of the Regional Study area, but it drains southward into the Muskingum and Mahoning River systems. The major watersheds of the regional study area are shown in Figure 2-108. Specifically, the proposed Lakefront plant site is bordered on the north by Lake Erie, the west by Conneaut Creek and on the east by Raccoon Creek. The project area itself contains a major portion of the Turkey Creek Basin, small sections of the Conneaut and Raccoon Creek drainage basins, four intermittent tributaries to Lake Erie, and several small ponds. Surface waters on or near the proposed site are shown in Figure 2-109.

b) Surface Water Quality Standards

Ohio Water Quality Standards

2.607
Ohio Water Quality Standards are established by the Ohio Environmental Protection Agency (OEPA) and the most recent version is

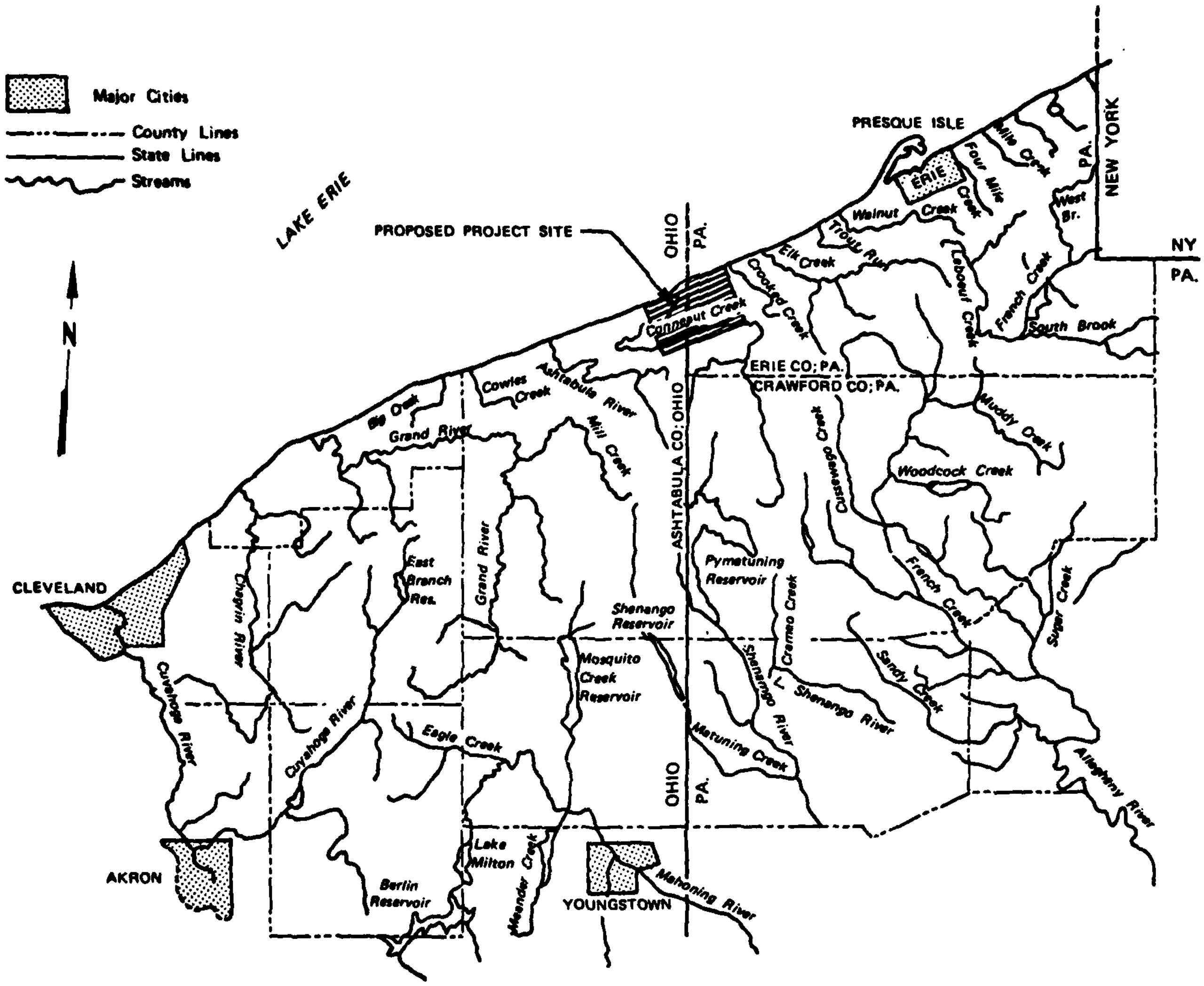


FIGURE 2–108 SURFACE WATERS IN THE AREA OF THE PROPOSED PROJECT

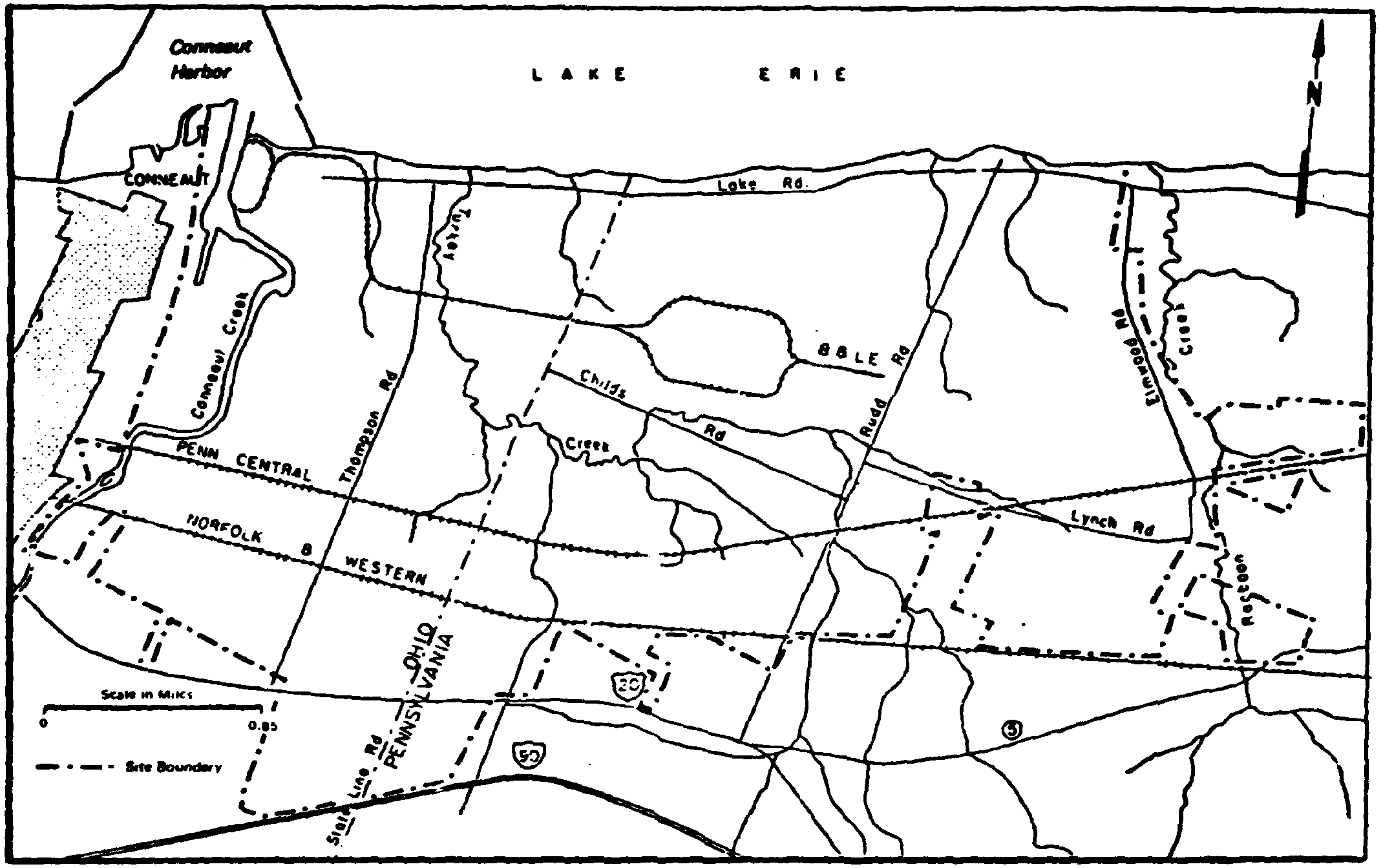


FIGURE 2–109 MAP OF THE PRINCIPAL FEATURES OF THE STUDY SITE

EP-1, effective 8 January 1975. The (OEPA) has proposed revisions to EP-1 but these revisions are still under review as of November 1977.* The philosophy of the Ohio standards is protection of all waters "for warm water fisheries, for primary contact recreation, for processing by conventional treatment into public, industrial, and agricultural water supplies, and for such other uses as are identified for specific waters..." General standards are established for all waters, for waters within 500 yards of a public water supply, with separate nutrient standards for the Lake Erie and Ohio River watersheds. Separate, and less stringent, standards are established for the Mahoning River watershed. Heated water effluents are subject to the following constraints (EP-17 (A)(2)(a)):

> "Water temperature of the epilimnion shall not exceed by more than $3^{o}F$ ($1.7^{o}C$) the water temperature which would occur if there were no temperature change of such waters attributable to human activities. In addition, at no time shall water temperature exceed at a depth three feet below the surface the maximum temperature indicated in the following tabulation:

Period		Maximum Temperatures F^{o}	C^{o}
January	1-31	35	1.7
February	1-28	38	3.3
March	1-15	39	3.9
	16-31	45	7.2
April	1-15	53	11.7
	16-30	60	15.6
May	1-15	64	17.8
	16-31	72	22.2
June	1-15	78	25.6
	16-30	83	28.3
July	1-31	85	29.4
August	1-31	85	29.4
September	1-30	81	27.2
October	1-31	71	21.7
November	1-30	58	14.4
December	1-31	46	7.8

* The present and proposed standards are compared later in this subsection.

2.608
EP-1-07 (A)(2)(a) must be satisfied at the boundary of a mixing zone which is constrained such that the mixing zone shall not: (EP-1-03 (B)(1)):

"(d) include spawning or nursery areas of any indigenous aquatic species, or
(e) interdict the migratory routes of any indigenous aquatic species, or
(f) include a drinking water supply."

2.609
Furthermore (EP-1-03 (B)(4)) in Lake Erie:

"(b) no mixing zone for an industrial discharge other than heat shall extend from the point of discharge more than one-tenth (1/10) of the width of the near shore area (as defined in EP-1-07 (B)(1)) at the point of discharge; and (c) for discharges of heat, conditions in a mixing zone, and in the circulating water, the discharge of which creates said mixing zone, shall be such that the temperature in said mixing zone and circulating water, considered in conjunction with the length of the period of residence therein of any indigenous aquatic species considered important and desirable by the Director or the Ohio Environmental Protection Agency, will not result in the death, impaired reproduction or growth, or increased vulnerability to predation, of a percentage of the total population of said species considered significant by the Director. In determining which species are desirable and important, and in determining what percentage of the total population is significant, the Director shall take into consideration the recommendations of the Great Lakes Water Quality Board of the International Joint Commission.

(d) No mixing zone shall include any bathing area where bathhouses and/or lifeguards are provided, and which was established prior to 1 January 1975.

Sources of wastewater (other than public sewerage systems and treatment works) having more than one discharge point in Lake Erie shall be limited to a total mixing area not larger than that which would be allowed if only one discharge point existed."

2.610
One apparent gap in the Ohio standards is the lack of a definition of a mixing zone for thermal effluents. The water quality standards (e.g., EP-1-07(A)(2)(a) states:

> "Water temperatures of the epilimnion shall not exceed by more than 3°F (1.7°C) the water temperature which would occur if there were no temperature change of such waters attributable to human activities."

These are only to apply outside of the mixing zone (EP-1-03(A)). However, the specific definition of mixing zone size for industrial discharges contained in EP-1-03(B)(4)(6) applies only to discharge other than heat. Other subsections place certain constraints on the location of mixing zones, and the conditions within the mixing zone, but there is no specific definition of mixing zone for thermal effluents.* The quantitative limits for various parameters covered by EP-1 are shown in Table 2-334.

2.611
Proposed revisions of Ohio WQS were adopted at the State level and became effective on February 14, 1978. The remaining portions are undergoing revision by the Ohio EPA or promulgation by the USEPA. They include an expanded anti-degradation policy, revised restrictions on the location of mixing zones, and standards based on water use designations for all water bodies of the State. Lake Erie is protected for use as exceptional warmwater habitat, public water supply, agricultural water supply, industrial, and bathing waters. Turkey Creek and Conneaut Creek are designated as coldwater habitat, agricultural water supply, industrial water supply and primary contact recreation. The revised Ohio water quality standards for Lake Erie are compared with the present standards, as well as the Pennsylvania standards, EPA criteria, and International Joint Commission criteria at the end of this subsection on Surface Water Quality Standards.

Pennsylvania Water Quality Criteria

2.612
Pennsylvania water quality criteria are issued under the Commonwealth's Act of 22 June 1937, P.L. 1987. The latest revisions, adopted 2 September 1971, are published under "Title 25: Rules and Regulations: Part I: Department of Environmental Resources; Chapter 93: Water Quality Criteria." The scope of these criteria dictate

* The proposed revision to the Ohio Water Quality Standards for Lake Erie no longer contain mixing zone size definitions for any facilities.

Table 2-334

Existing Ohio Water Quality Standards

Parameter	Applicability: Within 500 Yards of Public Water Intake	General	Lake Erie, Central Basin Near-Shore, East of Avon
pH, units		6.0-9.0	7.0-8.8
Dissolved Oxygen		Not less than 5.0 mg/ℓ daily average or 4.0 mg/ℓ at any time	Not less than 6.0 mg/ℓ or 80% saturation, whichever is greater
Dissolved Iron	<300 μg/ℓ	<1000 μg/ℓ	<300 μg/ℓ
Dissolved Solids	May exceed one but not both of the following, (1) 500 mg/ℓ monthly average nor exceed 750 mg/ℓ at any time (2) 150 mg/ℓ attributable to human activities	May exceed one, but not both of the following, (1) 1500 mg/ℓ (2) 150 mg/ℓ attributable to human activities	Monthly average <200 mg/ℓ Maximum day <250 mg/ℓ
Fecal Coliform	100/200[1]	200/400[1]	200/400[1]
Phenols	<1.0 μg/ℓ	<10 μg/ℓ	<1.0 μg/ℓ
Nitrate (N)	<8 mg/ℓ		
Ammonia		<1.5 mg/ℓ	
Un-ionized Ammonia as N			<0.02 mg/ℓ
Total Inorganic Nitrogen			<0.3 mg/ℓ
Chromium		<300 μg/ℓ	<50 μg/ℓ
Chromium (hexavalent)	<10 μg/ℓ	<50 μg/ℓ	
Cyanide	<0.005 mg/ℓ	0.2 mg/ℓ	0.5 μg/ℓ
Cyanide (free)		0.005 mg/ℓ	
Dissolved Manganese	<50 μg/ℓ	<1000 μg/ℓ	
Manganese			<50 μg/ℓ
Threshold Odor Number		<24 at 40°C	<10 monthly average <15 at any time
Arsenic		<50 μg/ℓ	<5 μg/ℓ
Barium		<800 μg/ℓ	<1 μg/ℓ
Cadmium		<5 μg/ℓ	<5 μg/ℓ
Chloride		<250 mg/ℓ	<35 mg/ℓ monthly average <50 mg/ℓ maximum day (dissolved)
Fluoride		<1.3 mg/ℓ	<0.15 mg/ℓ
Methylene Blue Active Substance		<0.5 mg/ℓ	<0.05 mg/ℓ
Lead		<40 μg/ℓ	<50 μg/ℓ
Mercury		<0.5 μg/ℓ	<0.3 μg/ℓ
Oil and Grease		<5 mg/ℓ	<0.05 mg/ℓ
Selenium		<5 μg/ℓ	<5 μg/ℓ
Silver		<1 μg/ℓ	<1 μg/ℓ
Copper		Varies with hardness	<10 μg/ℓ
Zinc		Varies with hardness	<50 μg/ℓ
Nickel		<0.025 mg/ℓ	<50 μg/ℓ
COD			<15 mg/ℓ
Carbon Chloroform Extractables			<0.05 mg/ℓ
Sulfates			<25 mg/ℓ monthly average; <40 mg/ℓ maximum day
Hardness			<130 mg/ℓ monthly average
Total phosphorus			<180 mg/ℓ maximum day

[1] Fecal coliforms are expressed as a geometric mean per 100 ml based on not less than 10 samples per 30-day period and the values not to be exceeded in more than 10% of such samples, except for the general standard which is based on five samples.

Source: Ohio Environmental Protection Agency.

that: "These criteria are based upon water uses which are to be protected and shall be considered by the Department in its regulation of discharges." The "standard" water uses considered include: (1) aquatic life (warm water fish), (2) water supply (domestic, industrial, livestock, wildlife, irrigation), (3) recreation (fishing, water contact sports, natural areas) and (4) other uses (power, treated water assimilation). Other water uses were considered for specific water bodies whenever applicable. General water quality criteria are as follows:

"(a) Water shall not contain substances attributable to municipal, industrial or other waste discharges in concentrations or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life."

"(b) Specific substances to be controlled shall include, other floating materials, toxic substances and substances which produce color, tastes, odors, turbidity or settle to form sludge deposits."

Specific water quality criteria vary depending on the surface water in question. Table 2-335 gives the Commonwealth's specific criteria for its portion of Lake Erie; Table 2-336 gives criteria for five specific creeks, and one general "basins of Lake Erie tributaries," near the proposed project site.

U.S. Environmental Protection Agency Criteria

2.613
While USEPA does not establish uniform national water quality standards, the Agency under FWPCA Amendments of 1972 and the Clean Water Act of 1977, is charged with ultimate responsibility for establishment of acceptable water quality standards in every State. These criteria are required by law to accurately reflect the latest scientific knowledge on the kind and extent of all identifiable effects on health and welfare which may be experienced from the presence of pollutants in any body of water. State water quality standards (which are a legal entity) should, in the future, be based upon a consideration of the USEPA's criteria and the local conditions in the State. USEPA criteria for several of the parameters or pollutants of interest are summarized in Table 2-337.

International Joint Commission Objectives

2.614
Under the terms of the Great Lakes Water Quality Agreement of 1972, the IJC is empowered to recommend specific water quality objectives for the Great Lakes. In developing water quality objectives the

Table 2-335

Water Quality Standards for the Pennsylvania Waters of Lake Erie

Parameter	All Waters Except Erie Harbor and Presque Isle Bay	Erie Harbor and Presque Isle Bay
pH, Units	6.7-8.5	7.0-9.0
Dissolved Oxygen	Not less than 6.0 mg/ℓ in epilimnetic waters; not less than necessary to support cold water fish in hypolimnetic waters	Minimum daily average not less than 5.0 mg/ℓ; not value less 4.0 mg/ℓ
Iron	<0.3 mg/ℓ	<0.3 mg/ℓ
Temperature	Not more than 5°F rise above ambient temperatures; not to be increased by heated waste discharge to temperatures in excess of 58°F; not to be changed by more than 2°F in any one-hour period	Not more than a 5°F rise above ambient temperature or a max. of 87°F, whichever is less; not to be changed by more than 2°F during any one-hour period
Dissolved Solids	<200 mg/ℓ	<500 mg/ℓ, monthly average <750 mg/ℓ, at any time
Bacteria	Monthly geometric mean of not less than 5 samples should not exceed 1000/100 ml total coliform, nor 200/100 ml fecal coliform	5000/100 ml coliform as monthly average, nor more than this number in more than 20% of the samples in any month, nor more than 20,000/100 ml in more than 5% of the sample
Taste and Odor	Phenols and other objectionable taste and odor producing substances should be substantially absent	Threshold odor number <24 at 60°C
Phosphorus	Prevent nuisance growths of algae, weed, and slimes	
Methylene Blue Active Substance		<0.5 mg/ℓ

Table 2-336

Pennsylvania Water Quality Standards for Selected Streams Near the Proposed Project Site

Parameter	Coverage: (1) Basins for L. Erie tributaries(1,2); (2) Elk Creek(1); (3) Conneaut Creek (main stream)(1)	Coverage: (1) French Creek (NY-PA state line to mouth)(3); (2) Turkey Creek (source to OH-PA state line); (3) Ashtabula Creek (source to OH-PA state line)
pH, Units	6.0-8.5	6.0-8.5
Dissolved Oxygen	Min. daily average 6.0 mg/ℓ; no value less than 5 mg/ℓ. For lakes, ponds and impoundments, no value less than 5 mg/ℓ at any point.	Min. daily average 5.0 mg/ℓ; no value less than 4.0 mg/ℓ. For the epilimnion of lakes, ponds, and impoundments, min. daily average of 5.0 mg/ℓ, no value less than 4.0 mg/ℓ.
Iron, Total	<1.5 mg/ℓ	<1.5 mg/ℓ
Temperature	Not more than 5°F rise above ambient temperatures; not to be increased by heated waste discharges to temperatures in excess of 58°F; not to be changed by more than 2°F during any one hour period.	Not more than a 5°F rise above ambient temperature on a maximum of 87°F, whichever is less; not to be changed by more than 20°F during any one hour period.
Dissolved Solids	<500 mg/ℓ, monthly average <750 mg/ℓ, at any time	<500 mg/ℓ, monthly average <750 mg/ℓ, at any time
Bacteria	Fecal coliform density in five consecutive samples shall not exceed a geometric mean of 200 per 100 ml.	Fecal coliform density in five consecutive samples shall not exceed a geometric mean of 200 per 100 ml.

Parameter	Coverage: (1) Basins for L. Erie tributaries(1,2); (2) Elk Creek(1); (3) Conneaut Creek (main stream)(1)	Coverage: (1) French Creek (NY-PA state line to mouth(3); (2) Turkey Creek (source to OH-PA state line); (3) Ashtabula Creek (source to OH-PA state line)
Ammonia Nitrogen	<0.5 mg/ℓ	For French Creek only: <1.5 mg/ℓ
Threshold Odor Number	--	For French Creek only: <24 at 60°C
Methylene Blue Active Substance	--	For French Creek only: <0.5 mg/ℓ

(1) Protected uses also includes migratory fish.

(2) Protected uses also includes cold water fish.

(3) Protected uses also includes boating.

Table 2-337

USEPA Criteria for Selected Water Quality Parameters

Parameter	Criterion	Comments
Ammonia	<0.02 mg/l (as un-ionized ammonia) for freshwater aquatic life.	Concentrations of un-ionized NH_3 is temperature and pH dependent. At 15°C pH of 7.0, a <u>total</u> ammonia concentration of 7.3 mg/l will imply a concentration of 0.2 mg/l un-ionized ammonia.
Cyanide	5.0 μg/l for freshwater aquatic life and wildlife.	Toxicity of HCN to fish may increase with increases in water temperature and decreases in levels of DO from saturation.
Oil and Grease	For domestic water supply: virtually free from oil and grease, particularly from the tastes and odors that emanate from petroleum products	Tainting of oysters has been found at concentrations of 0.01 mg/l of crude oil.
	For aquatic life: (1) 0.01 of the lowest continuous flow 96-hour LC 50 to several important freshwater species, each having a demonstrated high susceptibility to oils and petrochemicals.	Sublethal effects often seen at oil concentrations of 0.01 to 0.1 mg/l. Some effects seen at much lower levels for some aquatic species.
	(2) Levels of oils or petrochemicals in the sediment which cause deleterious effects to the biota should not be allowed.	
	(3) Surface waters shall be virtually free from floating oils (of any origin).	

Table 2-337 (Continued)

Parameter	Criterion	Comments
Dissolved Oxygen (DO)	Aesthetics: Water should contain sufficient DO to maintain aerobic conditions in the water column and, except as affected by natural phenomena, at the sediment water interface. Freshwater aquatic life: A minimum concentration of DO to maintain a good fish population is 5 mg/1.	
pH	5 to 9 for domestic water supplies; 6.5 to 9 for freshwater aquatic life.	
Phenol	1 μg/1 for domestic water supply, and to protect against fish flesh tainting	Acute (lethal) effects on aquatic life probable at concentrations above 1 mg/1, sublethal effects at concentrations above about 0.1 mg/1.
Sulfide - Hydrogen Sulfide	2 μg/1 undissociated H_2S for fish and other aquatic life, fresh and marine water.	Aquatic toxicity of sulfides may increase with decrease in pH; temperature and DO are also important factors.
Solids and Turbidity	For freshwater fish and other aquatic life: settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonably established norm for aquatic life.	
Chloride	None for aquatic life.	Several common freshwater species of fish can survive 10,000 mg/1 dissolved solids.

Table 2-337 (Continued)

Parameter	Criterion	Comments
Chlorine	Total residual chlorine: 2 μg/l for salmonid fish; 10 μg/l for other freshwater organisms.	Concentration of HOCl depends on pH. Toxic chloramines formed in reaction with nitrogenous compounds.
Arsenic	None for aquatic life. 50 μg/l for domestic water supplies.	Criterion for drinking water should be protective of aquatic life.
Copper	1 mg/l for domestic water supplies. For freshwater aquatic life, 0.1 times the 96-hour LC 50 of sensitive resident species.	Toxicity of Cu to aquatic life depends on alkalinity, pH and organic content of water.
Iron	0.3 mg/l for domestic water supplies. 1.0 mg/l for freshwater aquatic life.	Toxicity may vary in presence of other chemicals.
Lead	50 μg/l for domestic water supplies. 0.01 times the 96-hour LC 50 value of sensitive resident species for freshwater aquatic life.	Toxicity may vary in presence of other chemicals.
Manganese	50 μg/l for domestic water supplies. None for freshwater aquatic life.	Mn not considered to be a problem for freshwater aquatic life.
Zinc	5 mg/l for domestic water supplies. For freshwater aquatic life, 0.01 of the 96-hour LC 50 of sensitive resident species.	Toxicity of Zn modified by several environmental factors.
Aluminum	None.	

Source: Quality Criteria for Water, United States Environmental Protection Agency, 1976.

Commission adopted a policy of protecting all uses of the lake. For the most parameters the objectives are recommended to protect aquatic life. In other cases the most sensitive use which constrains a water quality parameter is public water supply, aesthetic, or recreational. The objectives are subject to continual review. Certain general and specific objectives were spelled out with the Agreement of 1972. In September of 1976, the Great Lakes Water Quality Board proposed new and revised objectives, and has also published objectives for other substances which are under review and have not been recommended for adoption. Article II of the Great Lakes Water Quality Agreement states the following general objectives.

> "The following general water quality objectives for the boundary waters of the Great Lakes System are adopted. These waters should be:

A. Free from substances that enter the waters as a result of human activity and that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life or waterfowl;

B. Free from floating debris, oil, scum and other floating materials entering the waters as a result of human activity in amounts sufficient to be unsightly or deleterious;

C. Free from materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance;

D. Free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life;

E. Free from nutrients entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae."

Annex I of the agreement provides specific quantitative objectives for total and fecal coliforms, dissolved oxygen, total dissolved solids, taste and odor, pH, total iron, phosphorus, radioactivity; and more general, use-oriented objectives for temperature. mercury and other toxic heavy metals, persistant organic contaminants, settleable and suspended materials, and oil, petrochemicals, and imiscible substances. Policies covering non-degradation, mixing zones, sampling data, and localized areas are also stated in general terms. Presently existing or proposed objectives for selected parameters are listed in Table 2-338.

Table 2-338

Comparison of Water Quality Criteria for Lake Erie[1]

Parameter	Ohio Water Quality Standards Existing	Ohio Water Quality Standards Proposed	IJC Objectives	PA Water Quality Criteria	USEPA Criteria
pH, Units	6.7-8.5	6.5-9.0	6.5-9.0	6.7-8.5	6.5-9.0
Dissolved Oxygen	6.0	6.0	6.0	6.0	5.0
Dissolved Iron	0.3	0.3	0.3	0.3	0.3
Temperature Increment, °F	3.0	3.0	---	5.0	---
Total Dissolved Solids	180.0	200.0	200.0	200.0	---
Un-ionized Ammonia	0.02	0.025	0.02	---	0.02
Cadmium	0.0005	0.0012	0.002	---	0.003
Chromium	0.003	0.05	0.05	---	0.05
Copper	0.005	0.005	0.005	---	variable
Phenols	0.0005	0.001	S/A	S/A	0.001
Zinc	0.015	0.03	0.03	---	variable
Arsenic	0.001	0.05	0.05	---	0.05
Residual Chlorine	---	0.002	0.002	---	0.002
Cyanide (A)	0.0005	0.005	0.005	---	0.005
Cyanide (Total)	---	0.025	---	---	---
Lead	0.05	0.03	0.025	---	variable
Mercury	0.0001	0.0002	0.0002	---	0.0002
Oil & Grease	0.05	5.0	---	---	---
Fluoride	0.15	1.8	1.2	---	1.5

[1] All values in mg/l unless otherwise indicated

S/A = Substantially Absent.

Comparison of Applicable Standards and Criteria for Lake Erie

2.615
Table 2-338 is a comparison of parametric values not be exceeded in the offshore waters of the central basin of Lake Erie under Ohio water quality standards, the proposed revisions to Ohio standards (as of November 1977), Pennsylvania water quality criteria, the International Joint Commission Objectives, and USEPA criteria for selected parameters. Note that Ohio proposed numerical standards for total dissolved solids, chromium, zinc, arsenic, residual chlorine, cyanide (A), lead, mercury, and fluoride have been revised such that they more nearly coincide with IJC objectives, while phenols has been revised to that suggested by the USEPA.

c) Physical Characteristics of Surface Waters

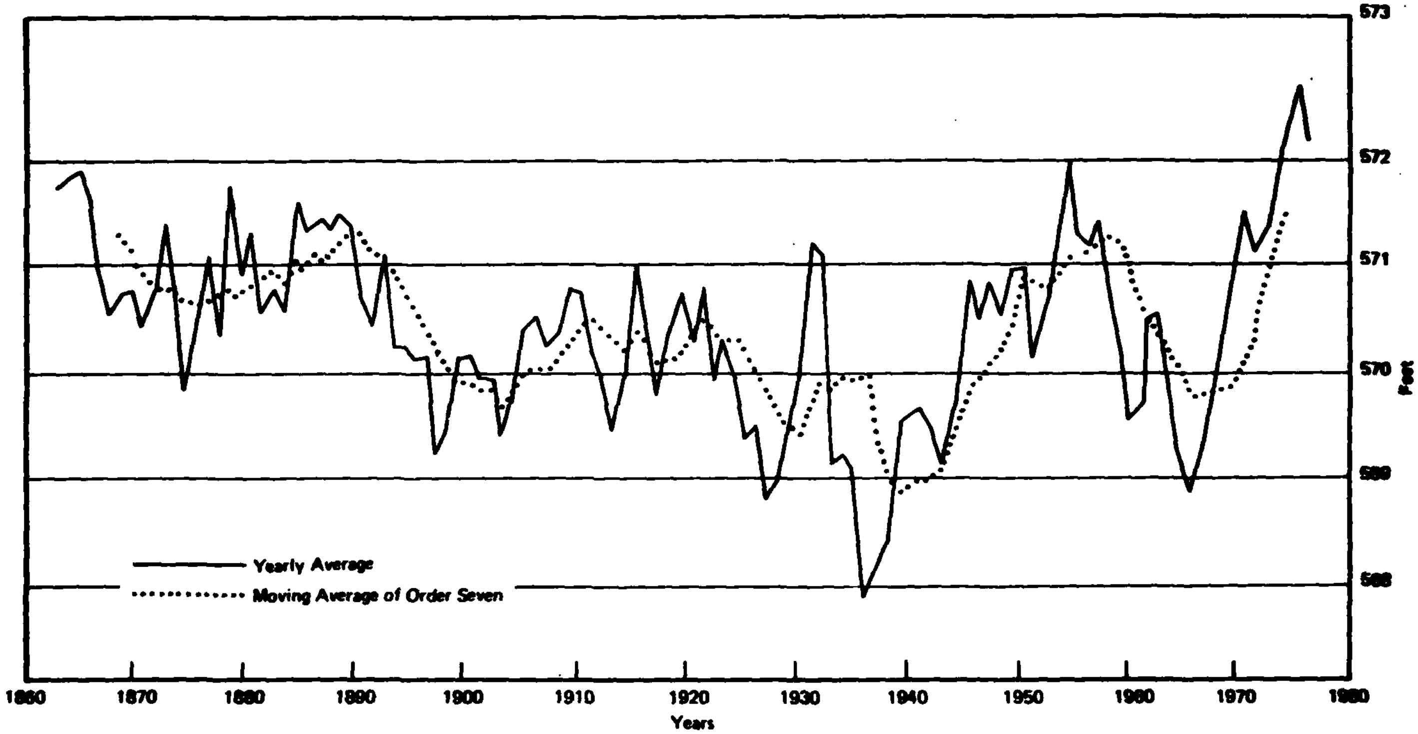
Lak Erie

Lake Levels

2.616
The Lake Survey Center of the National Oceanic and Atmospheric Administration (NOAA) has monitored Lake Erie water levels since 1859. Based on their observations the average water elevation for the lake is 570.39 feet (above sea level) or 568.6 feet in terms of International Great Lakes Datum (IGLD). Variations in the surface elevation (water level) of Lake Erie can be classified as long period variations, seasonal variations, and short period variations. The long-term variations are the cumulative result of a variety of events in the lake basin, one of which is the rate of precipitation. Presently, water levels in Lake Erie are higher than normal as a result of increased precipitation in the Great Lakes Basin. Long-term variations in the surface elevation of Lake Erie are shown in Figure 2-110. Seasonal variations can cause changes in lake elevation of up to 1.2 feet. Maximum seasonal elevations are generally attained in midsummer following spring runoff events while minimum levels occur in February when water is stored throughout the basin in the form of ice and snow. Short period variations are caused by winds blowing over the lake's surface or by differences in atmospheric pressure over the lake. During such short period disturbances, the level of one area of the lake rises while another area drops. Short period variations can be of considerable amplitude; a rise of 2.45 feet is expected once every two years, whereas a rise of 4.3 feet is expected once every 50 years.

Lake Currents

2.617
The general circulation patterns of Lake Erie have been studied since 1895, and the most comprehensive study was performed by the Federal Water Pollution Control Administration in 1963-1964. (2-156) Methods



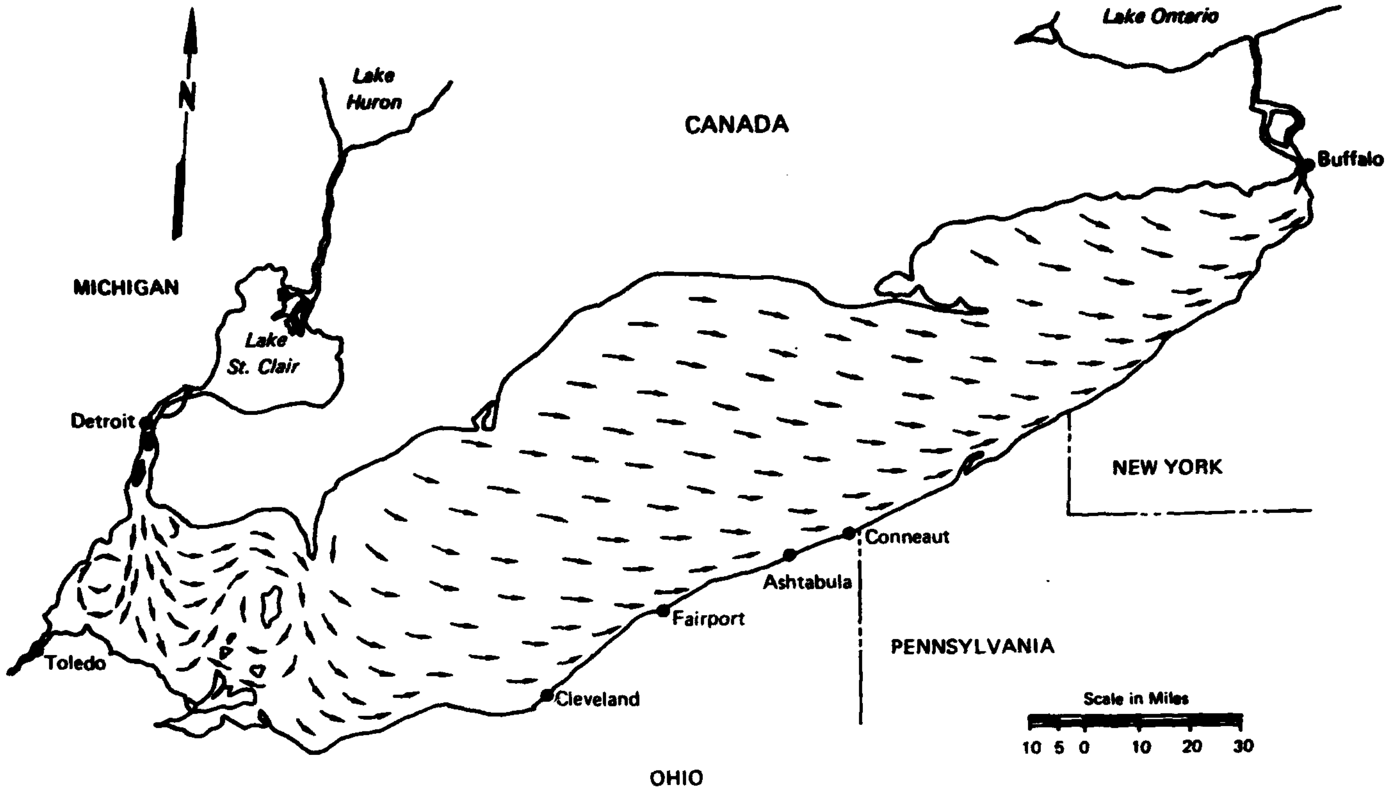
Source: Paul Knuth and International Great Lakes Datum.

FIGURE 2–110 LAKE ERIE YEARLY AVERAGE WATER LEVEL—(IGLD) 1860-1976

used to study current patterns have included drift carfs and bottles, drogues, seabed drifters, dye release, and direct current meters. Predominant summer flow patterns revealed by these studies are shown in Figures 2-111 and 2-112. The surface flow shows the effects of the Detroit River inflow in the western basin and the dominant effect of the southwesterly winds coupled with the Coriolis effect to produce east south easterly surface flow through most of the central and eastern basins. This movement of water contributes to the general surface circulation pattern which is predominantly north eastward along the southern shore of the lake. Near shore, the current is relatively uniform from surface to bottom. However, in the offshore waters of the central and eastern basins, there is a current regime at depth which is directed counter to the surface flow. Another study of current flow indicates generally easterly flow near the north shore of the basin which culminates in a brisk current to the east at Long Point (2-157). These current patterns represent seasonal averaged conditions which provide indications of the long-term transport of water and any associated constituents. At any particular location and time, the currents will probably be quite different from those indicated here. Mean speeds are lower than instantaneous veolcities, and complete reversals of current direction within two or three days are common in the near shore areas.

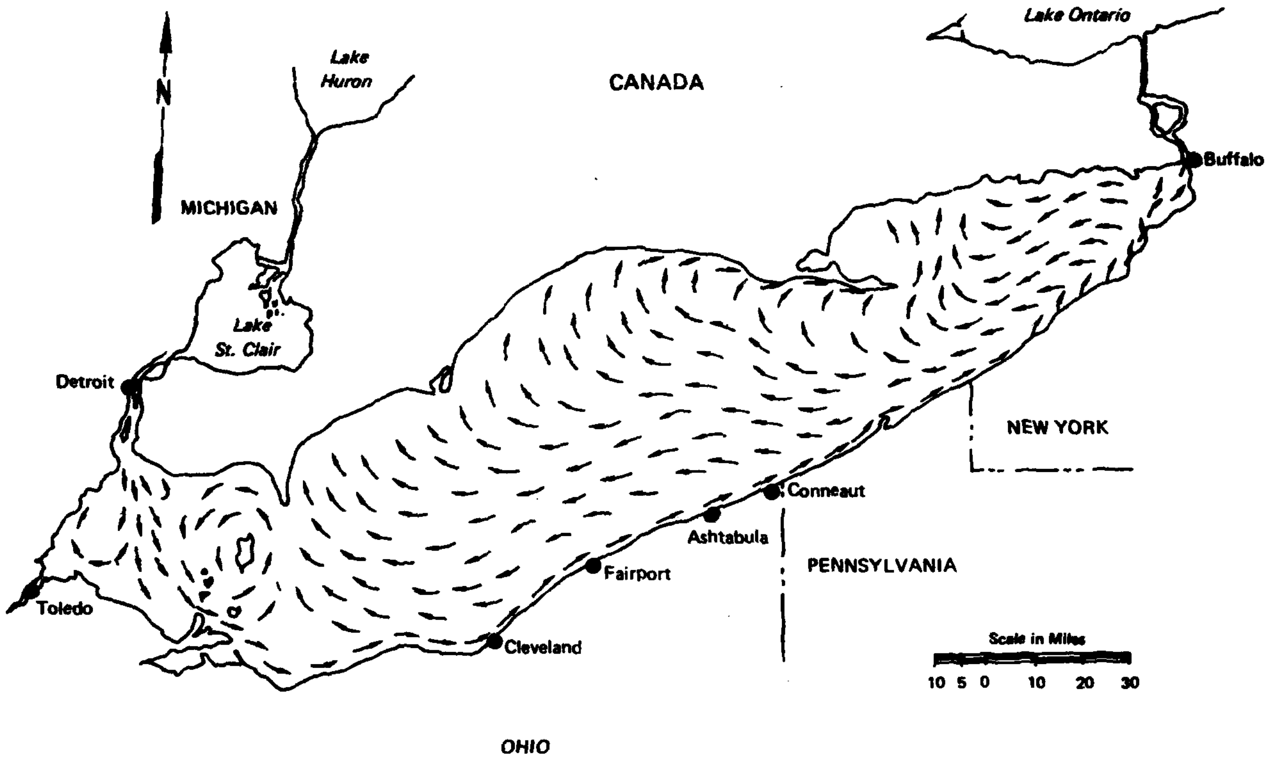
2.618
Three separate current studies have been conducted in the near shore area of Lake Erie between Conneaut, OH, and Erie, PA, by C.E. Herdendorf of Ohio State University (2-158, 159, 160). Combining these studies resulted in 75 individual current observations within 10 kilometers of shore. Based on these data, currents were found to be alongshore to the northeast 36 percent of the time, alongshore to the southwest 28 percent of the time, onshore 22 percent of the time, and offshore the remaining 14 percent. Current velocities range from stagnant to 30 cm/sec and there was no perceptible correlation between wind direction and current direction. Overall these studies indicate a resultant (vector average) speed of 5 cm/sec with onshore and easterly longshore components. These data are generally in agreement with the current patterns shown in Figures 2-111 and 2-112.

2.619
As a part of the field sampling effort at the proposed Lakefront Plant a series of Lake Erie current observations were made, data from initial measurements on 2 May 1977 shows the same pattern of northeasterly flow with speeds ranging from 4 to 20 cm/sec in the open lake, and 4 to 8 cm/sec in the eastern portion of Conneaut Harbor. Within the harbor, current velocities averaged 6 cm/sec just east of the U.S. East Breakwater. The currents, observed at 1 m intervals in the vertical water column, were roughly uniform with



Source: "Lake Erie Environmental Summary, 1963–1964," U.S. Dept. of the Interior, Federal Water Pollution Control Administration, Great Lakes Region, May 1968.

FIGURE 2–111 DOMINANT SUMMER SURFACE FLOW PATTERN IN LAKE ERIE (Direction Only)



Source: "Lake Erie Environmental Summary, 1963–1964," U.S. Dept. of the Interior, Federal Water Pollution Control Administration, Great Lakes Region, May 1968.

FIGURE 2–112 DOMINANT SUMMER BOTTOM FLOW PATTERN IN LAKE ERIE (Direction Only)

depth, with a tendency for peak speeds at two to three meters below the surface. Winds on this occasion were out of the southwest at 4 meters per second (m/sec). Current observations on 7 July 1977 indicate an easterly longshore flow at the 9-meter contour, with a clockwise eddy in the lee of the U.S. East Breakwater. During this period winds were 4 m/sec from the west. Current speeds averaged 18 cm/sec in the open lake and 10 cm/sec in the harbor. Bottom currents were quite similar to surface flow in both magnitude and direction. Surface currents on 3 August 1977, during a west wind of 3 m/sec, were predominantly toward the east at 15 to 25 cm/sec. Bottom currents on this occasion were onshore at 15 to 30 cm/sec. During northeasterly winds at 4 m/sec on 15 August 1977, surface currents were directed toward the southwest at 15 to 24 cm/sec. Bottom currents did not exhibit a clear pattern on this date. These observations tend to indicate that surface currents off the proposed site are nearly parallel to the wind direction, and that bottom currents are of roughly the same magnitude as the surface flow. However, bottom current directions do not indicate any strong correlation with wind direction off the site.

Stream Flows in Inland Waters

2.620
Stream flow patterns can generally be determined by studying precipitation patterns, basin geology and topography, evaporation, runoff characteristics, underground water conditions, and identifying structures or activities which would alter the movement of water in a given basin (i.e. diversions, dams, withdrawals).

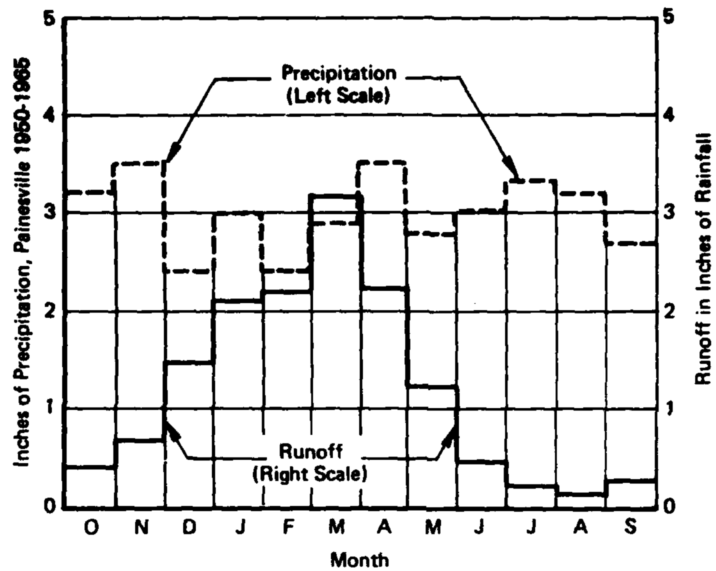
2.621
Precipitation. The average annual precipitation in the Ashtabula County and Erie County area is about 99 centimeters, with a range from 84 to 114 centimeters. Precipitation along the shores of Lake Erie is at the lower end of this range; while the higher rates are more typical of locations 15 kilometers or more south of the lake shore. Precipitation in the form of snow and sleet ranges from about 100 to 250 centimeters per year, with the upper end of this range representative of a "snow belt" about 16 kilometers wide (north to south) centered about 16 kilometers south of the lake and running parallel to the lake shore. (2-161) Monthly average precipitation does not vary significantly from month to month. Thus, long periods without rainfall are rare, but protracted dry spells of about three weeks occur about once every five years. Monthly average precipitation rates for the period 1962-1971 are presented in Table 2-339 and Figure 2-113.

Table 2-339

Monthly Average Precipitation in the Regional Study Area -- 1962-1971
(Centimeters)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Highest Monthly	Lowest Monthly	Total Annual Average
Erie WSO, PA	5.82	4.27	5.87	7.82	7.57	7.90	8.94	8.25	8.53	7.59	10.9	8.43	19.6	1.8	93.75
Corry, PA	8.64	5.84	8.10	9.98	8.99	8.94	13.2	10.5	8.69	9.04	12.8	11.5	30.5	2.3	116.3
Conneautville, PA	6.83	5.38	7.44	8.94	8.05	7.82	13.1	11.6	9.35	8.43	9.68	9.17	19.7	0.10	105.8

Source: "Northeast Ohio Water *Plan-Main Report*," *Ohio Department of* Natural Resources, November 1972.



Source: "Northeast Ohio Water Plan – Main Report," Ohio Department of Natural Resources, November, 1972.

FIGURE 2–113 AVERAGE MONTHLY PRECIPITATION AND RUNOFF – GRAND RIVER NEAR MADISON, OHIO

Geology and Topography

2.622
The topography of the Lake Erie drainage basin in the Regional Study Area can be best described as a steep bluff rising abruptly at the shore of Lake Erie to an elevation of as much as 149 feet followed by a relatively flat plain extending inland about 1.8 miles and a steel escarpment which begins about 2.9-3.8 miles inland. Landward of the escarpment the landscape can be characterized as gently rolling hills. The watershed divide between the Lake Erie drainage basin and the Allegheny River Basin consists of a relatively flat plain with lakes and wetlands which drain very slowly. Headwaters of streams in the Lake Erie drainage basin begin as small meandering channels with floodplains where energy is dissipated laterally. However, in the lower reaches of these streams this energy becomes vertical causing most streams to cut steep sided gorges through glacial till down to the bedrock surface. During this transition the creek bottom substrate changes from rock and mud to shale (2-162). The soils in the region are extremely varied with many abrupt changes, which is typical of areas that experienced glaciation. Heavy clays predominate, and surface layers may range in thickness from about three feet to over 100 feet. (2-163). Such high clay-content soils have a very low water permeability. This results in relatively small retentions of precipitation in the ground (i.e, high surface runoffs), and thus extremely low stream flows during prolonged periods of dry weather (2-163).

2.622a
Evaporation. The average annual evaporation in the Regional Study Area is about 62 centimeters for the land areas and 76 centimeters for Lake Erie. The evaporation rate over land is generally lower near the lake shore (53 centimeters/year) than for inland areas. (2-161) Evaporation rates are affected by: winds (generally out of the southwest with average velocity of 8 km/hr; air temperatures (mean annual 9 to 13°C; low monthly average -3 to 5°C in January; high monthly average 20 to 22°C in July); solar radiation (highest in June, lowest in December); relative humidity (highest near Lake Erie) and surface area (generally low, except in winter and spring when snow or water covers large areas). All these factors combine to make the evaporation rate vary significantly with the season. For example, at Jamestown, PA evaporation rates range from a minimum of less than 7.6 centimeters per month in October to a maximum of almost 18 centimeters per month in July. (2-162)

2.622b
Runoff. Runoff volume, as measured by stream flows, shows a high peak in (or near) March of each year. The low runoff period is in the period from June to November. Runoff in the Lake Erie basin (Pennsylvania portion) averages about 0.014 $m^3/km^2/sec$.

2.622c
Underground Water Conditions. Most of the land in the area of the project site has very limited groundwater storage. In Ashtabula County, for example, the clayey soil is underlain with shale bedrock in most areas, and individual wells will seldom yield more than 19 liters per minute. (2-161) Hence, most of the area streams have little groundwater to sustain their flows during dry weather periods.

2.622d
Diversions, Withdrawals, and Dams. At present, the inland surface waters in the Regional Study Area are relatively free of major diversions, withdrawals, and dams. The most common structure found in the area is either an in-stream or upground storage reservoir, the latter fed by pumps from a nearby stream. In Ashtabula County, Rock Creek has an upground storage reservoir from the Grand River, and Jefferson has an upground storage reservoir from Mill Creek. In Erie County, Union City has an in-stream reservoir on French Creek, and Edinboro Lake is man-made. The water in Edinboro Lake is regulated to maintain sufficient water for boating and swimming in the summer. (2-162). Three reservoirs are associated with Sixteenmile Creek in the northeast corner of Erie County. Major impoundments in Crawford County include Pymatuming Reservoir, Woodcock Creek Lake and Conneaut Lake. The general purposes for these (and other) impoundments include water supply, flood control and recreation.

Flows in the Major Streams

2.622e
The stream flows for the major streams in the Regional Study Area are given in Table 2-340. It is apparent from these data that nearly all of the streams in the area will be virtually dry for a seven-day period every other year. Only the lower reaches of Conneaut Creek, French Creek, and Grand River have significant flow for the assimilation of wastewaters.

Flows in Streams on the proposed Project Site

2.623
No historical data are available on flow rates of streams traversing the project site. However, on site flow measurements were conducted in Turkey Creek (near Station TC-4) during rainfall events. The data show that flows during the August-November 1977 period ranged from 0.5m^3/sec (prior to storm events) at about 1.5-2 m3/sec (peak storm periods). The lower reaches of Turkey Creek and Raccoon Creek usually have some flow throughout the year but also are likely to dry for substantial portions of the low-flow period each (June to November). Like other streams in the area, their flows may be expected to be highly variable, with a relatively quick response to

Table 2-340

Stream Flow Data for Major Streams in the Project Area

Station	Drainage Area (km^2)	Avg. Annual Discharge (m^3/sec)	Low Flow Discharges 7 Day - 2 year (m^3/sec)	Low Flow Discharges 7 day - 10 year (m^3/sec)
A. Grand River Basin				
1. Phelps Creek, near Windsor, OH	66.3	1.01	0.013	0.0054
2. Rock Creek near Rock Creek, OH	179	2.14	0.0	0.0
3. Mill Creek near Jefferson, OH	212	2.98	--	--
4. Grand River near Madison, OH	1,500	18.29	0.1	0.029
B. Ashtabula River Basin				
1. Ashtabula River near Ashtabula, OH	313	4.13	0.0	0.0
C. Conneaut Creek Basin				
1. Conneaut Creek at Conneaut, OH	453	6.80	0.128	0.042
2. Conneaut Creek at Cherry Hill, PA	386	5.27	0.127	0.071
D. Other Lake Erie Basin Streams				
1. Crooked Creek at N. Springfield, PA	44.8	0.736	0.028	--
2. Little Elk Creek near Plateau, PA	45.1	0.617	--	--

Table 2-340 (Continued)

Station	Drainage Area (km^2)	Avg. Annual Discharge (m^3/sec)	Low Flow Discharges 7 Day - 2 Year (m^3/sec)	Low Flow Discharges 7 Day - 10 Year (m^3/sec)
3. Elk Creek at North Girard, PA	250	3.62	0.057	0.028
4. Walnut Creek at Wells Library, PA	69.7	0.838	0.042	0.023
5. Mill Creek at Erie, PA	23.8	0.28	0.034	0.023
6. Six Mile Creek at Harborcreek, PA	39.9	0.632	0.010	--
7. Seven Mile Creek at Harborcreek, PA	7.5	0.096	0.0057	0.0028
8. Twelve Mile Creek at Moorheadville, PA	17.1	0.28	0.0028	--
9. Sixteen Mile Creek at North East, PA	25.4	--	--	--
E. Allegheny River Basin				
1. French Creek at Carters Corner, PA	539	11.7	0.510	0.27

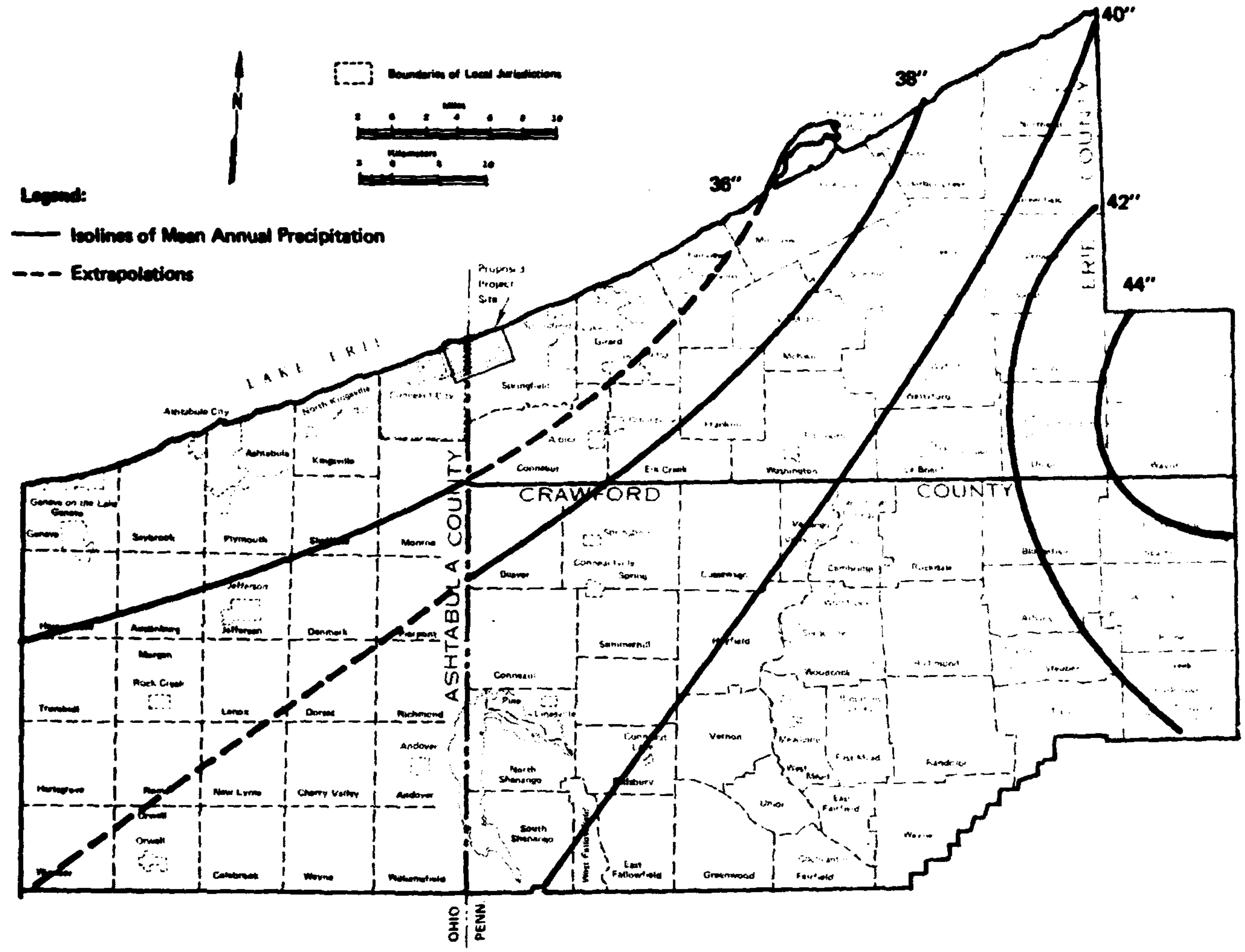
Source: "Northeast Ohio Water Plan--Main Report," Ohio Department of Natural Resources, November, 1972.
"Executive Summary of the Comprehensive Waste and Water Quality Management Study of the Pennsylvania Portion of the Lake Erie Basin and the Remaining Portion of Erie County," Pennsylvania Department of Environmental Resources, February 1976.

precipitation events. The flow in the various creeks may be estimated using the annual runoff figure of 0.014 m^3km^2/sec which is an average for the Pennsylvania portion of the Lake Erie Basin. The total surface area of the Turkey Creek watershed was estimated to be 20.3 square kilometers based on the U.S. Geological Survey maps (7.5 minutes series) of the creek basin. The average annual flow in Turkey Creek is thus estimated to be 0.28 m^3/sec. Using the same approach for Raccoon Creek, the watershed area is estimated to be 22.2 square kilometers, and the average annual flow in the creek is thus estimated to be 0.28 m^3/sec. Many of the creeks and rivers in the Regional Study Area do flood, including portions (or tributaries) of Ashtabula River, Conneaut Creek, Grand River, Cowles Creek, and several other streams. (2-164)

d) Stormwater Runoff in the Regional Study Area

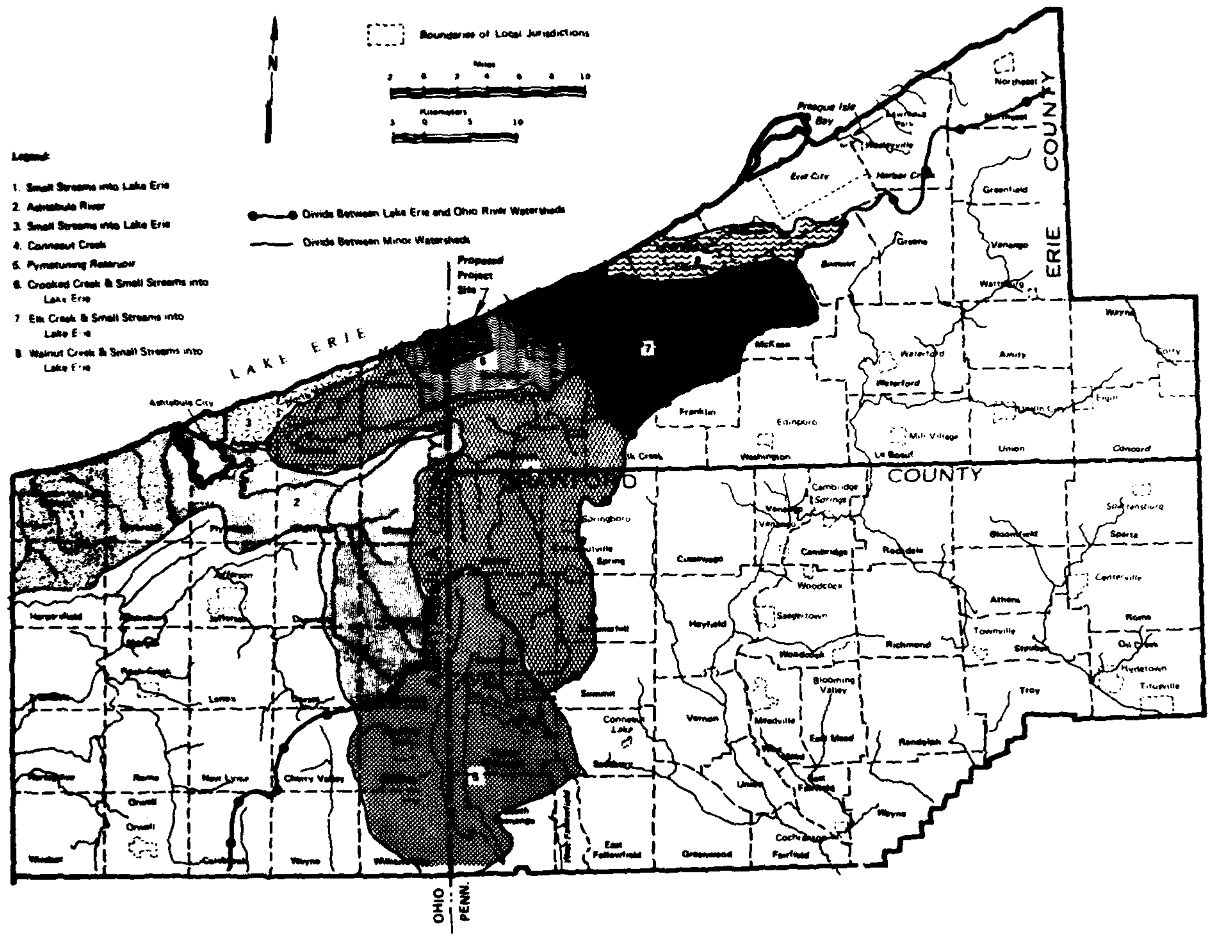
Quantity and Dynamics

2.624
The average annual rainfall in the study area ranges from 36 to 46 inches per year as shown in Figure 2-114 and increases with the distance south from Lake Erie. The northern part of the Regional Study Area drains into Lake Erie, whereas the southern part drains eventually into the Mississippi River. The major drainage basins in the study area are delineated in Figure 2-115. Drainage in the Regional Study Area is influenced by a number of natural factors, including soil type and topography. Much of Ashtabula, Erie, and Crawford Counties is covered with relatively impermeable soil sometimes accompanied by a fragipan layer (hard pan) which is a soil condition that tends to aggravate flooding and contributes to drainage problems. The lack of topographic relief throughout much of this region also contributes to drainage problems (refer to Figures 2-116 through 2-119). Increased urbanization has affected drainage in the Regional Study Area. The increase in paved area and the replacement of natural drainage channels with piping has caused an increase in the fraction of rainwater that leaves the area as surface runoff (by decreasing groundwater infiltration and interception by plants), and the concentration of runoff from storm events into a smaller time period, greatly intensifying peak flows. The greatest extent of urbanization in the Regional Study Area has occurred primarily along the Lake Erie coastline. The influence of the above factors in each of the eight major drainage basins in the Regional Study Area (refer to Figure 2-115) has been analyzed. Based on this analysis, average runoff coefficients have been estimated and the average annual runoff in each drainage basin has been calculated. The results of this analysis are presented in Table 2-341.



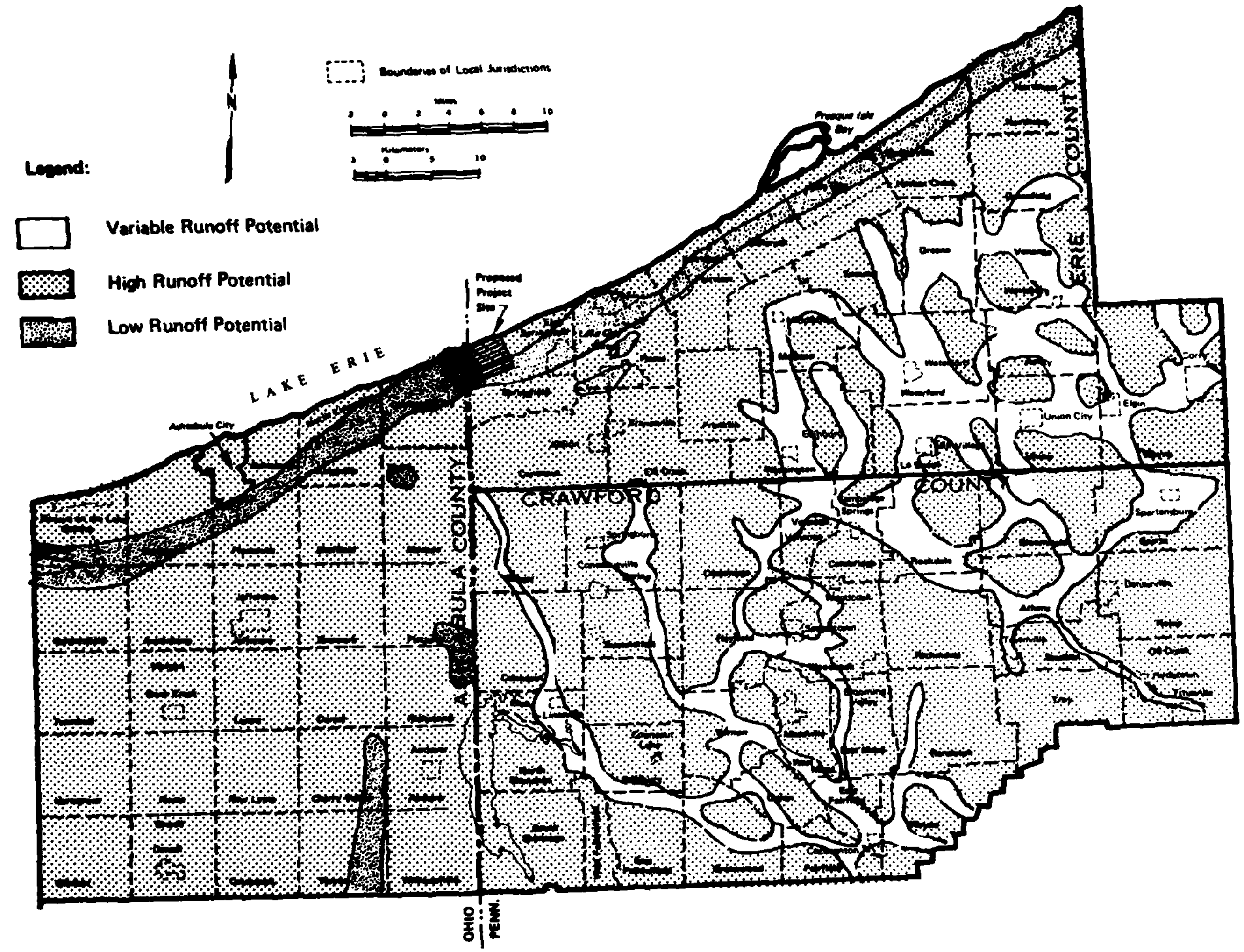
Source: *Erie County Storm Drainage Plan*, 1974; COWAMP Upper Allegheny River Basin, Great Lakes Basin Framework Study; Arthur D. Little, Inc., estimates.

FIGURE 2–114 AVERAGE ANNUAL PRECIPITATION IN THE REGIONAL STUDY AREA



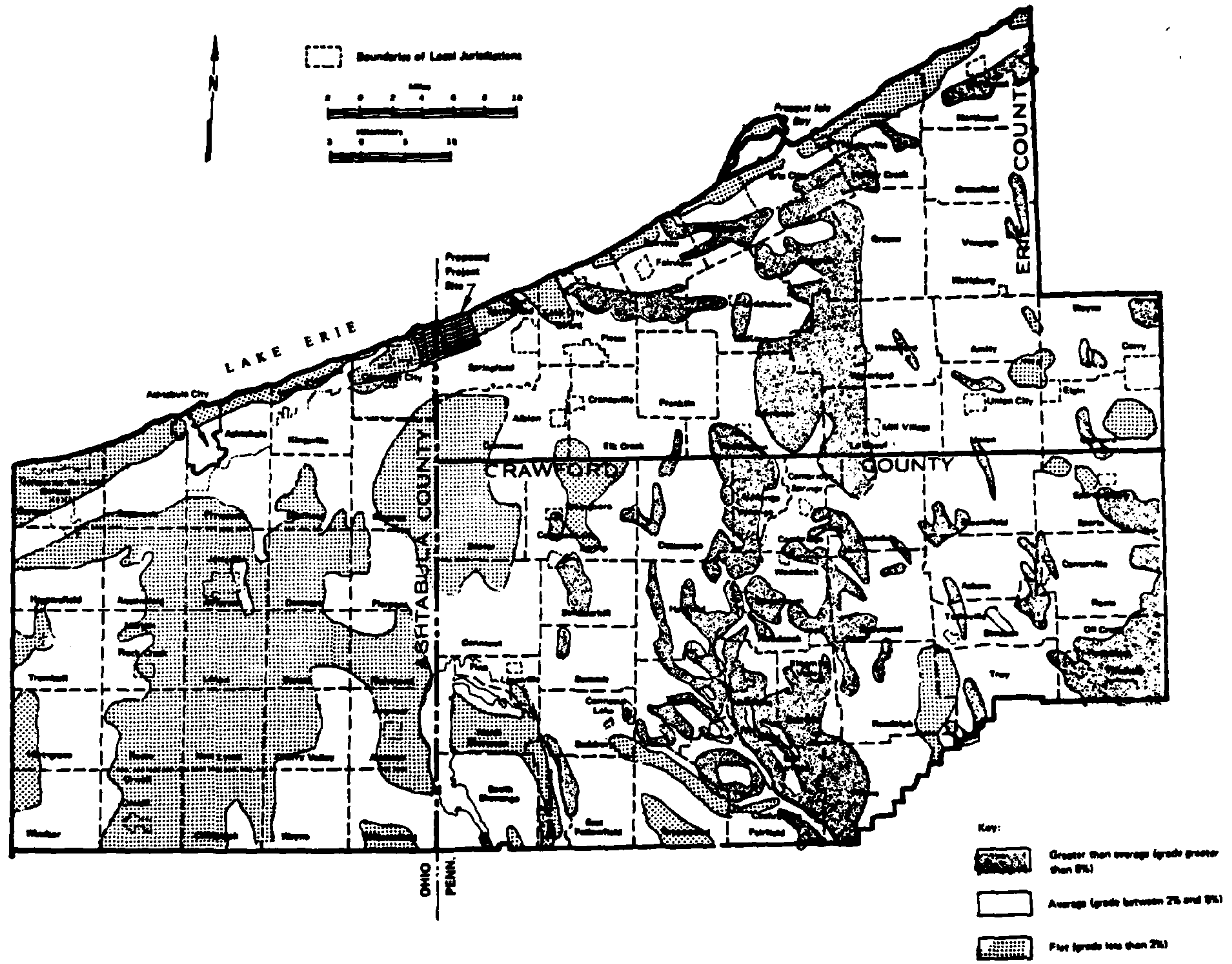
Source: Arthur D. Little, Inc.

FIGURE 2–115 DRAINAGE BASINS IN THE REGIONAL STUDY AREA



Source: Soil Survey of Ashtabula County, Ohio; Soil Survey of Erie County, Pennsylvania; and Crawford County Comprehensive Plan.

FIGURE 2–116 RUNOFF POTENTIAL OF NATURAL SOILS ON THE REGIONAL STUDY AREA



Source: Arthur D. Little, Inc., estimates.

FIGURE 2–117 AREAS OF DIFFERING SLOPES IN THE REGIONAL STUDY AREA

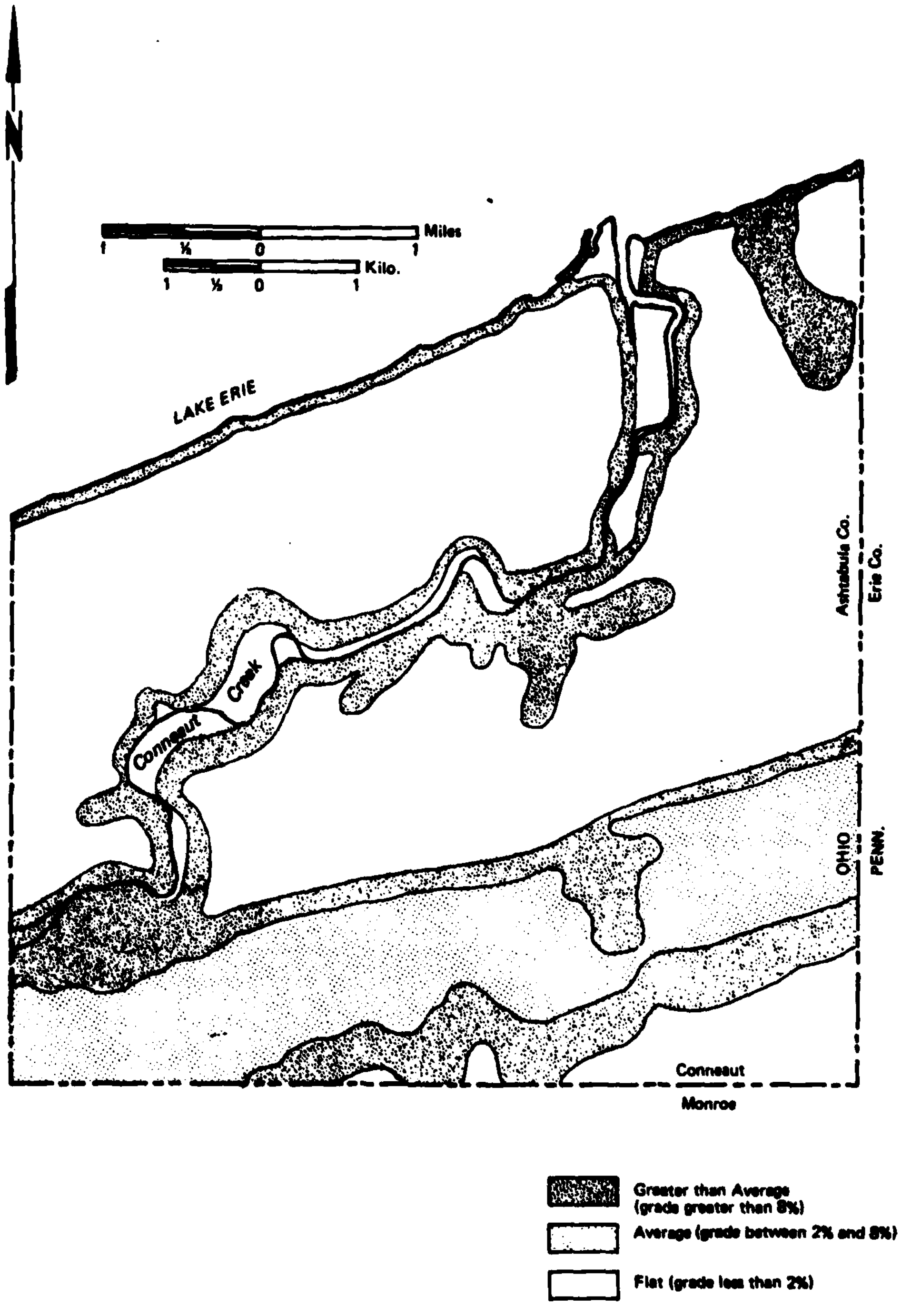


FIGURE 2–118 AREAS OF DIFFERING SLOPES IN CONNEAUT CITY

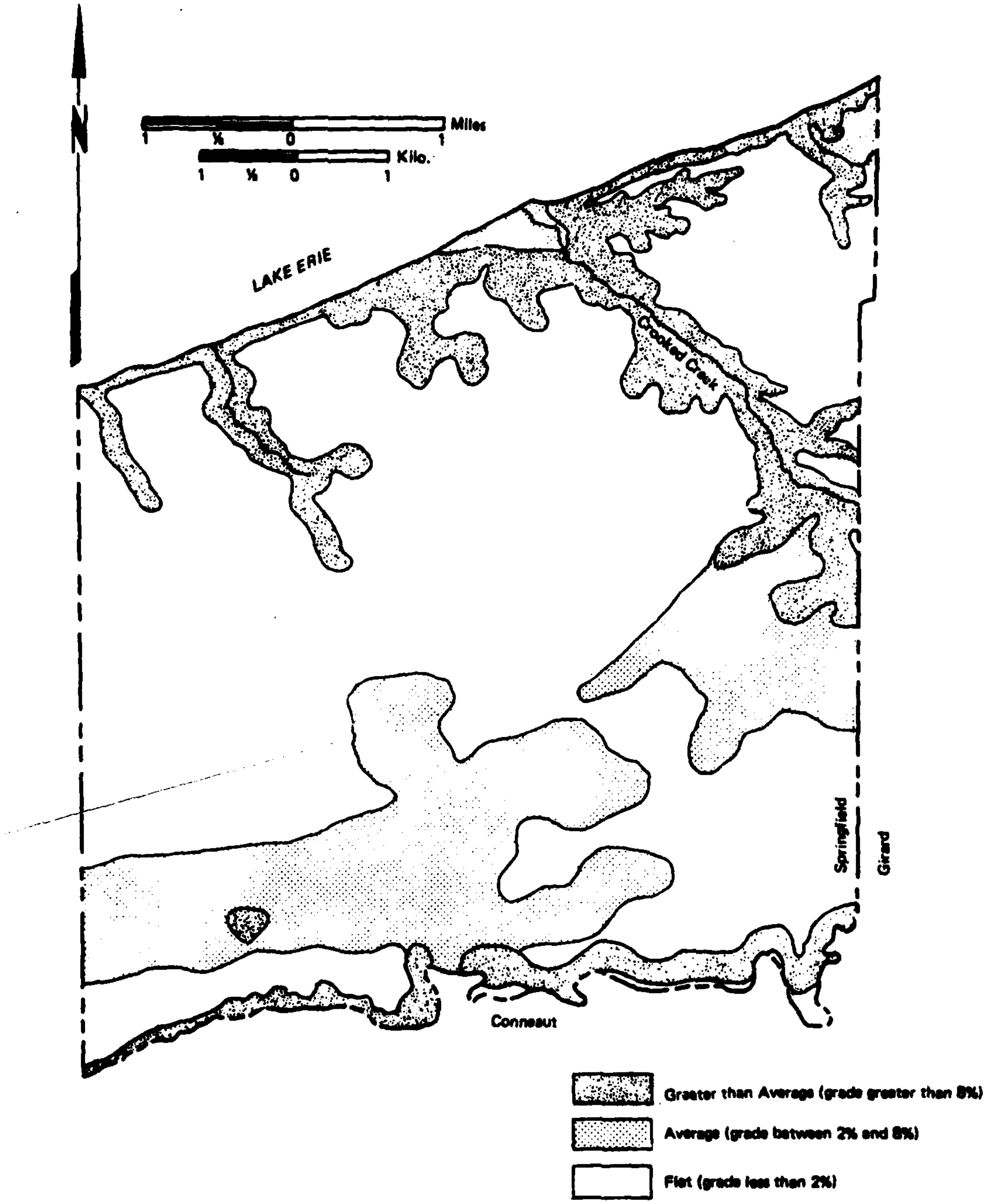


FIGURE 2–119 AREAS OF DIFFERING SLOPES IN THE SPRINGFIELD AREA

Table 2-341

Annual Runoff from Drainage Basins in the Regional Study Area

Drainage Basin No.	Acreage	Estimated Average Annual Rainfall (In.)	Estimated Average Runoff Coefficient	Average Annual Runoff Per Acre (10^6 Gallons Per Acre Per Year)	Total Annual Runoff in Basin (1) (10^6 Gallons Per Year)
1 (2)	42,274	35	0.35	0.333	14,100
2	89,519	37	0.35	0.352	31,500
3	12,903	35	0.35	0.333	4,290
4	132,806	37	0.40	0.402	53,400
5	103,868	39	0.40	0.424	44,000
6	27,498	36	0.30	0.293	8,000
7	69,825	36	0.45	0.440	30,700
8	29,180	37	0.50	0.502	14,700

(1) These values *will be significantly* greater than the reported average annual stream flow out of the drainage basin. The rationale (used here) is accurate only in estimating the volume of runoff reaching local waters. Not *all this water* will leave the much larger drainage basin as *streamflow since some* will be lost to the atmosphere through evaporation.

(2) See Figure 2-115 for drainage basins.

Source: Arthur D. Little, Inc.

Quality

2.625
Many factors affect the quality of stormwater runoff, including climate, rainfall characteristics and quality, topography, and soil conditions. Land use, however, is the prime determinant of the types and quantities of pollutants that will be exposed to removal through stormwater runoff. Generally speaking, runoff from urban land may include high concentrations of heavy metals and petroleum products not found in the runoff from rural areas. In rural areas, wooded acreage will shed relatively pure runoff. Runoff from croplands, however, may have high suspended solids levels and contain contaminants associated with fertilizer or pesticide use. Land use in each drainage basin in the Regional Study Area was analyzed and grouped in categories suitable for determining runoff quality. Through careful inspection of the relevant USGS 7.5 minute topographical maps and analysis of the most recent land use statistics available, Table 2-342 was developed. In the analysis, the total land area was divided into rural acreage and urban acreage. The urban land use category was further subdivided into land undergoing industrial, commercial, residential, or public and institutional use. Roads and road right-of-ways were generally divided proportionally by area among the industrial, commercial, residential, and public and institutional categories; railroads and their right-of-ways were considered industrial land, as were in some cases, airports. Rural land was subdivided into two categories: "agricultural land" and "other rural land." The category "other rural" includes such land use as rural public land, rural residential land, vacant or underdeveloped land, recreational facilities, State game lands, and water bodies.

2.626
Annual contaminant loadings (tons of contaminants per acre per year) for each land use were then developed and contaminant contributions from combined sewer overflows and livestock waste were estimated. Insufficient data were available to determine loadings for "agricultural land" and "other rural land" separately, and therefore, general loadings were developed for the combined category "rural land." These factors and estimates were used to develop Table 2-343, the average annual contaminant loadings in each drainage basin. All values shown are very rough estimates of the average mass of contaminants entering local water bodies through surface runoff each year. A review of the data contained in Table 2-343 shows that loadings from combined sewer overflows are relatively minor when compared to contaminant loadings from urban and nonurban runoff and livestock wastes. Livestock wastes may contribute significant loadings of nitrogen and BOD to local water bodies. In drainage basins 2, 4 and 5 (Ashtabula River, Conneaut Creek, and Pymatuning

Table 2-342

Land Use in the Drainage Basins of the Regional Study Area
Drainage Basin 1 -- Small Streams - Lake Erie

Municipality	Urban Acres: Industrial	Urban Acres: Commercial	Urban Acres: Residential	Urban Acres: Public and Institutional	Rural Acres: Agricultural	Rural Acres: Other Rural	Total Acres(1)	Approximate Percentage of Municipality by Area in the Drainage Basin
Ohio								
Ashtabula City	90	72	519	130	0	90	901	19%
Austinburg Township	0	0	0	0	285	732	1,017	6
Geneva-on-the-Lake(2)	←	260	→		210	700	1,170	100
Geneva Township	112	199	33	868	2,769	9,479	13,460	100
Geneva Village	←	540	→		120	396	1,056	100
Harpersfield Township	8	42	0	37	4,363	1,696	6,146	37
Saybrook Township	355	486	0	102	4,987	12,594	18,524	92
Total	565	799	1,352(3)	1,137	12,734	25,687	42,274	

(1) Totals do not always add due to rounding.

(2) Land use distributions for Geneva-on-the-Lake and Geneva Village were unavailable. The values given are estimates only.

(3) Includes 800 acres of urban land in Geneva-on-the-Lake and Geneva Village.

Table 2-342

Land Use in Drainage Basin 2 -- (Ashtabula River)

	Urban Acres				Rural Acres			
Municipality	Industrial	Commercial	Residential	Public and Institutional	Agricultural	Other Rural	Total Acres[1]	Approximate Percentage of Municipality by Area in the Drainage Basin
Ohio								
Ashtabula City	871	133	725	247	0	1,627	3,603	76%
Ashtabula Twp	264	98	546	537	73	3,181	4,699	55
Denmark Twp	0	0	0	0	1,739	1,202	2,941	19
Dorset Twp	0	0	0	0	201	90	291	2
Kingsville Twp	0	0	0	0	319	1,145	1,464	17
Monroe Twp	0	128	0	37	5,269	14,517	19,951	81
Pierpont Twp	0	18	4	41	10,151	7,050	17,264	96
Plymouth Twp	73	119	0	221	1,611	6,693	8,717	60
Richmond Twp	0	9	0	22	7,814	3,337	11,182	66
Saybrook Twp	10	12	23	2	57	133	237	1
Sheffield Twp	16	5	0	45	4,324	8,140	12,530	83
Pennsylvania								
(Erie County)								
Conneaut Twp	65	3	0	33	2,528	3,827	6,640	24
Totals	1,299	525	1,298	1,185	34,086	50,942	89,519	

[1] Totals do not always add due to rounding.

Table 2-342 (Continued)

Land Use in Drainage Basin 3 -- (Small Streams - Lake Erie)

Municipality	Urban Acres				Rural Acres			
	Industrial	Commercial	Residential	Public and Institutional	Agricultural	Other Rural	Total Acres(1)	Approximate Percentage of Municipality by Area in the Drainage Basin
Ohio								
Ashtabula City	95	7	51	13	0	71	237	5%
Ashtabula Twp	791	11	0	60	82	2,900	3,845	45
Conneaut City	500	32	148	41	747	1,338	2,807	16
Kingsville Twp	0	25	22	118	247	898	1,310	15
North Kingsville	197	124	17	620	509	3,237	4,704	88
Totals	1,533	199	238	852	1,585	8,444	12,903	

(1) Totals do not always add due to rounding.

Table 2-342 (Continued)

Land Use in Drainage Basin 4 -- (Conneaut Creek)

	Urban Acres				Rural Acres			
Municipality	Industrial	Commercial	Residential	Institutional	Agricultural	Other Rural	Total Acres(1)	Approximate Percentage of Municipality by Area in the Drainage Basin
Ohio								
Conneaut City	545	93	309	73	5,714	6,951	13,685	78%
Kingsville Twp	0	101	6	471	1,117	4,051	5,746	67
Monroe Twp	0	30	0	9	1,236	3,405	4,680	19
North Kingsville	27	17	0	85	70	446	645	12
Pierpont Twp	0	0	0	0	421	270	691	4
Pennsylvania								
(Crawford County)								
Conneaut Lake Area	0	0	0	0	1,883	3,206	5,089	15
Conneautville Area	26	128	39	174	23,670	43,959	67,996	70
(Erie County)								
Albion Boro	102	15	102	63	236	196	714	100
Conneaut Twp	592	25	0	299	9,770	8,847	19,533	71
Cranesville Boro	82	2	33	5	215	265	603	100
Elk Creek Twp	66	11	0	27	5,172	5,096	10,372	48
Springfield Twp	0	0	0	0	1,446	1,606	3,052	15
Total	1,440	422	489	1,206	50,950	78,298	132,806	

(1) Totals do not always add due to rounding.

Table 2-342 (Continued)

Land Use in Drainage Basin 5 — (Pymatuning Reservoir)

	Urban Acres				Rural Acres			
Municipality	Industrial	Commercial	Residential	Public and Institutional	Agricultural	Other Rural	Total Acres[1]	Approximate Percentage of Municipality by Area in the Drainage Basin
Ohio								
Andover Twp	0	30	0	824	4,846	8,101[2]	13,801	85%
Andover Village	87	35	85	67	139	227	640	100
Richmond Twp	0	4	0	0	3,300	1,944[3]	5,256	32
Williamsfield Twp	0	68	0	153	4,140	3,396[4]	7,756	47
Pennsylvania								
(Crawford County)								
Conneaut Lake Area	0	0	0	0	2,395	6,048	8,443	25
Conneautville Area	1	7	0	9	6,925	12,861	19,804	20
Fallowfield Area	0	0	0	0	804	1,369	2,173	8
Pymatuning Area	18	95	33	293	9,207	36,349	45,995	90
Total	106	239	118	1,355	31,756	70,295[6]	103,868	

(1) Totals do not always add due to rounding.

(2) Includes 2,775 acres in Pymatuning Reservoir.

(3) Includes 240 acres in Pymatuning Reservoir and 294 acres in public park land adjoining the Reservoir.

(4) Includes 566 acres in Pymatuning Reservoir.

(5) Includes 12,555 acres in Pymatuning Reservoir.

(6) Includes 16,136 acres in Pymatuning Reservoir.

Table 2-342 (Continued)

Land Use in Drainage Basin 6 -- (Crooked Creek and Small Streams - Lake Erie)

	Urban Acres				Rural Acres			
Municipality	Industrial	Commercial	Residential	Public and Institutional	Agricultural	Other Rural	Total Acres (1)	Approximate Percentage of Municipality by Area in the Drainage Basin
Ohio								
Conneaut City	58	0	0	0	436	559	1,053	6%
Pennsylvania								
(Erie County)								
Conneaut Twp	0	0	0	0	542	835	1,377	3
East Springfield Boro	33	4	14	42	1,007	1,101	2,200	100
Elk Creek Twp	0	0	0	0	331	298	629	3
Girard Twp	69	15	0	2	1,827	1,809	3,723	19
Platea Boro	6	2	0	6	646	461	1,121	62
Springfield Twp	627	54	0	59	7,398	9,256	17,395	83
Total	793	75	14	109	12,187	14,319	27,498	

(1) Totals do not always add due to rounding.

Table 2-342 (Continued)

Land Use in Drainage Basin 7 -- (Elk Creek and Small Streams - Lake Erie)

Municipality	Urban Acres: Industrial	Urban Acres: Commercial	Urban Acres: Residential	Urban Acres: Public and Institutional	Rural Acres: Agricultural	Rural Acres: Other Rural	Total Acres(1)	Approximate Percentage of Municipality by Area in the Drainage Basin
Pennsylvania								
(Erie County)								
Elk Creek Twp	0	0	0	0	2,933	2,578	5,511	25%
Fairview Boro	0	0	0	0	89	56	145	17
Fairview Twp	45	34	28	75	4,122	3,383	7,687	44
Franklin Twp	0	42	0	10	7,977	5,848	13,878	77
Girard Boro	132	49	302	309	307	411	1,511	100
Girard Twp	618	139	46	22	7,227	7,819	15,871	81
Lake City Boro	170	28	274	57	84	495	1,109	100
McKean Twp	5	63	105	27	10,688	7,817	18,704	82
Middleboro	0	9	34	25	193	89	349	100
Platea Boro	22	9	0	22	314	329	696	38
Springfield Twp	0	0	0	0	237	272	509	2
Summit Twp	2	3	0	3	866	628	1,502	10
Washington Twp	0	0	0	0	778	565	1,343	5
Waterford Twp	0	0	0	0	500	510	1,010	3
Total	994	376	789	550	36,315	30,800	69,825	

(1) Totals do not always add due to rounding.

Table 2-342 (Continued)

Land Use in Drainage Basin 8 -- (Walnut Creek and Small Streams - Lake Erie)

	Urban Acres				Rural Acres			
Municipality	Industrial	Commercial	Residential	Public and Institutional	Agricultural	Other Rural	Total Acres (1)	Approximate Percentage of Municipality by Area in the Drainage Basin
Pennsylvania								
(Erie County)								
Fairview Boro	45	25	94	76	185	267	692	83%
Fairview Twp	308	230	303	513	3,443	3,414	8,211	47
Greene Twp	0	16	0	16	1,313	1,234	2,580	11
McKean Twp	1	10	9	4	1,681	1,236	2,942	13
Millcreek Twp	74	75	404	387	2,072	3,766	6,777	31
Summit Twp	108	116	94	124	3,620	3,916	7,978	52
Total	536	472	904	1,120	12,314	13,833	29,180	

(1) Totals do not always add due to rounding.

Source: Arthur D. Little, Inc. estimates.

Table 2-343

Estimated Tons of Contaminants Reaching Local Surface Waters Annually from Surface Runoff Under Baseline Conditions

Drainage Basin 1
(Small Streams-Lake Erie)
Average Annual Runoff
16,100 million gallons

	Total Solids	N	P	BOD_5	Fecal Coliform(1)	COD	Zn	Cu	Pb	Fe	Cr
• Combined Sewer Overflow	0	0	0	0	0	0	0	0	0	0	0
• Agricultural Wastes (Livestock)	600	50	4	150	10^{13}	N/E	N/E	N/E	N/E	N/E	N/E
• Runoff from Urban and Non-urban Land	65,000	150	>40	>750	$>10^{16}$	5,000	15	1-2	15	650	2-3
Total (rounded)	65,000	200	>45	>900	$>10^{16}$	5,000	15	1-2	15	650	2-3

(1) Colonies per year.

N/E = Not Estimated.

Drainage Basin 2
(Ashtabula River)
Average Annual Runoff
36,000 million gallons

	Total Solids	N	P	BOD_5	Fecal Coliform(1)	COD	Zn	Cu	Pb	Fe	Cr
• Combined Sewer Overflow	60	3	.6	20	$X\ 10^{14}$	25	N/E	N/E	N/E	N/E	N/E
• Agricultural Wastes (Livestock)	1,500	150	10	400	10^{14}	N/E	N/E	N/E	N/E	N/E	N/E
• Runoff from Urban and Non-urban Land	130,000	200	~80	~1,400	$\sim10^{16}$	10,000	30	1.5-3	15-20	1,200	2-4
Total (rounded)	130,000	350	~90	~1,800	$\sim10^{16}$	10,000	30	1.5-3	15-20	1,200	2-4

(1) Colonies per year.

N/E = Not Estimated.

Table 2-343 (Continued)

Drainage Basin 3
(Small Streams-Lake Erie)
Average Annual Runoff
49,000 million gallons

	Total Solids	N	P	BOD_5	Fecal Coliform(1)	COD	Zn	Cu	Pb	Fe	Cr
• Combined Sewer Overflow	0	0	0	0	0	0	0	0	0	0	0
• Agricultural Wastes (Livestock)	70	5	.5	20	10^{12}	N/E	N/E	N/E	N/E	N/E	N/E
• Runoff from Urban and Non-urban Land	23,000	70	~15	~300	$\sim 10^{16}$	1,500	6	1	9	300	1.5
Total (rounded)	23,00	75	15	320	$\sim 10^{16}$	1,500	6	1	9	300	1.5

(1) Colonies per year.

N/E = Not Estimated.

Drainage Basin 4
(Conneaut Creek)
Average Annual Runoff
60,000 million gallons

	Total Solids	N	P	BOD_5	Fecal Coliform(1)	COD	Zn	Cu	Pb	Fe	Cr
• Combined Sewer Overflow	50	3	.5	20	10^{14}	20	N/E	N/E	N/E	N/E	N/E
• Agricultural Wastes (Livestock)	2,800	250	20	700	10^{14}	N/E	N/E	N/E	N/E	N/E	N/E
• Runoff from Urban and Non-urban Land	190,000	250	~100	~2,000	$\sim 10^{16}$	15,000	40	1-4	10-20	1,500	2-4
Total (rounded)	190,000	500	~120	~2,700	$\sim 10^{16}$	15,000	40	1-4	10-20	1,500	2-4

(1) Colonies per year.

N/E = Not Estimated.

Table 2-343 (Continued)

Drainage Basin 5
(Pymatuning Reservoir)
Average Annual Runoff
49,500 million gallons

	Total Solids	N	P	BOD_5	Fecal Coliform(1)	COD	Zn	Cu	Pb	Fe	Cr
• Combined Sewer Overflow	0	0	0	0	0	0	0	0	0	0	0
• Agricultural Wastes (Livestock)	2,000	180	10	500	10^{14}	N/E	N/E	N/E	N/E	N/E	N/E
• Runoff from Urban and Non-Urban Land	140,000	200	>80	>1,500	$>10^{16}$	12,000	30	.5-2.5	6-10	1,000	1-3
Total (rounded)	140,000	380	>90	>2,000	$>10^{16}$	12,000	30	.5-2.5	6-10	1,000	1-3

(1) Colonies per year.

N/E = Not Estimated.

Drainage Basin 6
(Crooked Creek and Small Streams, Lake Erie)
Average Annual Runoff
9,410 million gallons

	Total Solids	N	P	BOD_5	Fecal Coliform(1)	COD	Zn	Cu	Pb	Fe	Cr
• Combined Sewer Overflow	0	0	0	0	0	0	0	0	0	0	0
• Agricultural Wastes (Livestock)	400	35	3	100	10^{13}	N/E	N/E	N/E	N/E	N/E	N/E
• Runoff from Urban and Non-urban Land	39,000	60	>25	>400	$>5 \times 10^{15}$	3,000	9	.3-.9	3-4.5	340	.5-1
Total (rounded)	39,000	95	>30	>500	$>5 \times 10^{15}$	3,000	9	.3-.9	3-4.5	340	.5-1

(1) Colonies per year.

N/E = Not Estimated.

Table 2-343 (Continued)

Drainage Basin 7
(Elk Creek and Small Streams-Lake Erie)
Average Annual Runoff
34,100 million gallons

	Total Solids	N	P	BOD_5	Fecal Coliform(1)	COD	Zn	Cu	Pb	Fe	Cr
• Combined Sewer Overflow	0	0	0	0	0	0	0	0	0	0	0
• Agricultural Wastes (Livestock)	1,000	100	8	300	10^{14}	N/E	N/E	N/E	N/E	N/E	N/E
• Runoff from Urban and Non-urban Land	100,000	150	>60	>1,000	$>10^{16}$	8,000	20	1-2	10	900	1.5-2.5
Total (rounded)	100,000	250	>70	>1,300	$>10^{16}$	8,000	20	1-2	10	900	1.5-2.5

(1) Colonies per year.

N/E = Not Estimated.

Drainage Basin 8
(Walnut Creek and Small Streams-Lake Erie)
Average Annual Runoff
16,100 million gallons

	Total Solids	N	P	BOD_5	Fecal Coliform(1)	COD	Zn	Cu	Pb	Fe	Cr
• Combined Sewer Overflow	0	0	0	0	0	0	0	0	0	0	0
• Agricultural Wastes (Livestock)	400	30	3	100	10^{13}	N/E	N/E	N/E	N/E	N/E	N/E
• Runoff from Urban and Non-urban Land	45,000	100	>30	>550	$>10^{16}$	3,000	10	1-1.5	10	500	1.5-2
Total (rounded)	45,000	130	>30	>650	$>10^{16}$	3,000	10	1-1.5	10	500	1.5-2

(1) Colonies per year.

N/E = Not Estimated

Source: Arthur D. Little, Inc. estimates based on estimated material averages for non-point source loadings by USEPA, and existing land use in the Regional Study Area.

Reservoir) a large fraction of the total estimated nitrogen load is attributed to this source. However, the estimated loadings of phosphorus and suspended solids from livestock wastes are generally minor when compared to loadings from other sources.

2.627
Due to the concentration of urban development in localities along the Lake Erie coastline, those drainage basins comprising a narrow band of land adjacent to the lake shore (e.g., drainage basins 1 and 3, small streams draining into Lake Erie) receive a more significant proportion of their total contaminant load from urban runoff than do other portions of the Principal Study Area. Similarly, those drainage basins encompassing large inland areas (e.g., Drainage Basins 2 and 4, Ashtabula River and Conneaut Creek) receive a greater percentage of their total contaminant load from nonurban runoff. The above conclusions, are based on an analysis of average conditions throughout the drainage basins; although it is understood that conditions can vary widely within each drainage basin. For instance, both Conneaut Creek and the Ashtabula River drain primarily rural areas, however, the quality of water in the vicinities of Conneaut City and Ashtabula City is almost certainly dominated by urban area loadings. Land use trends in the Regional Study Area indicated that residential, commercial and industrial land usages are expected to continue to increase in each drainage basin, with the possible exception of Drainage Basin 2 (Ashtabula River). Any increases in urban land use is assumed to be accompanied by a decline in rural and vacant acreage. As a result of the trend towards urbanization, the loadings of urban-related contaminants, such as heavy metals, are expected to increase through 1990. Drainage Basin 8 (Walnut Creek) is expected to continue to experience (for the region) a relatively rapid rate of urbanization under baseline conditions. By 1990, the loadings of chromium, copper, and lead to surface waters in this drainage basin might increase by 40 percent if estimated national averages for urban loadings developed by the USEPA are reflected in this basin.

2.628
Prior to interpreting the estimates presented in the previous tables factors such as contaminant loading, variation in chemical composition and the generality of the analytical methodology should be considered. Each of these is defined below:

Loadings to Local Surface Waters. Generally, if the contaminant loadings (i.e., tons per year) to each small creek and tributary of a large river are calculated and summed, they greatly exceed the flux of contaminants out of the mouth of the river. Although chemical changes are partially responsible for this difference, another primary cause is the settling out of

suspended solids and absorbed species somewhere between the upper reaches of the tributaries and the lake interface. Average unit contaminant loadings (i.e., tons per acre per year) as presented here, are based on the size of the drainage basin considered. The average unit loadings for Conneaut Creek, for instance, based on the discharge of contaminants at the mouth are far less than those based on a measure of the contaminants entering each small tributary. Local surface waters are taken here to include those streams, lakes, creeks, etc., that are no more than approximately one-quarter mile from the contaminant source.

Variation of Chemical Forms. The analysis conducted here considers only such gross categories as total nitrogen, total phosphorus, etc. In actuality, nitrogen, phosphorus, and other contaminants can exist in a variety of chemical forms, each relating to water quality and interacting with biota in different ways. If a given change in land use indicates that the total nitrogen load decreases, it is not necessarily implied that the loading of nitrogen in each of its forms has declined. This fact needs to be recognized in any assessment of the impacts of such a land use change.

Generality of Analysis. The purpose of this analysis is to summarize runoff quality in the Regional Study Area. The methodology utilized is capable of doing that, but nothing more. There is no doubt that the quality of stormwater runoff is strongly correlated to land use. However, the average results presented here cannot be considered to accurately represent the quality of stormwater runoff from any specific stream. Such a determination requires a more complete data base and complex analytical methodologies.

Types of Runoff

2.629
Some of the older urban centers in the Regional Study Area, including Erie City, Girard Borough, Albion Borough, Conneaut City, and Ashtabula City are partially serviced by combined or infiltrated sewer systems. In combined systems, stormwater runoff is drained into the sanitary sewer system, but in infiltrated systems, stormwater and groundwater enter the sanitary sewer system through cracks and other unplanned channels. During large storms, the flows in these systems may exceed the capacity of the local sanitary sewage treatment plant and result in the discharge of large volumes of untreated sewage to local water bodies. The total pollutant loadings from combined sewer overflows in the Regional Study Area are minor when compared to other non-point contaminant sources (notably runoff from nonurban land) although the pollutant concentrations may be

quite high, as shown in Table 2-344. It is expected that the volume of combined sewer overflow in the Regional Study Area will decrease because new systems have separate networks for stormwater and sewage and planning efforts have been stepped up to minimize overflow events at existing treatment plants. The estimated volumes and quality of sewage overflows in the Regional Study Area are presented in Tables 2-345 and 2-346, respectively, and the values shown were used to determine some of the contaminant loadings given previously in Table 2-343.

Urban Runoff

2.630
The quality of urban stormwater runoff is variable, as shown in Table 2-347. The quality of any particular sample will depend, among other things, on the local land use, topography, intensity of rainfall, timing of sampling within the storm period, street cleaning frequency, local traffic and antecedent dry days. In general, urban stormwater runoff is not as heavily laden with pollutants as sanitary sewage with the exception of heavy metals which may be found in urban runoff in concentrations 10 to 100 times greater than the typical concentrations in sanitary sewage. Sources of pollutants found in urban runoff include de-icing chemicals (Cl), corrosion from buildings and their a purtenances (Cn and Zn), automobile traffic (heavy metals, asbestos, slowly biodegradable petroleum products, rubber and particulate material), lawn runoff (organics, nutrients, and pesticides) and animal feces (BOD and coliform). In establishing the baseline urban runoff pollutant loading given previously in Table 2-343, the loading factors shown in Table 2-348 were used. These factors are based primarily on statistical results for the northeastern United States presented in the 1975 EPA report Water Quality Management Planning for Urban Runoff.* It is not known whether these averages are applicable to the urban areas within the Principal Study Area, and therefore, the loading factors are considered only very rough estimates.

Livestock Wastes

2.631
Livestock wastes may enter surface waters in the runoff from feedlots and lands used for manure disposal and when animals water in streams. The amount of pollutants from these sources is ultimately dependent on the total amount of waste produced. Amounts of these types of loadings have been calculated using the livestock conversion factors

* Assuming 0.46 curb miles per acre of street and an average of 0.27 acres of street per acre of urban land, based on the data presented in this source.

Table 2-344

Characteristics of Combined Sewer Overflows

Characteristic	Range[1]	Erie City (Average)[2]	Erie City (Sample)[2]	Ashtabula City[3]	Typical[4]
BOD_5 (mg/l)	30-600	51	112	139	100-700
COD (mg/l)	-	-	123	-	-
TSS (mg/l)	20-1,700	322	104	197	150-500
TS (mg/l)	150-2,300	-	516	-	-
Volatile TS (mg/l)	15-820	-	174	-	120-350
pH	4.9-8.7	-	7.2	-	-
Settleable Solids (ml/l)	2-1,550	-	3.0	-	-
Organic N (mg/l)	1.5-33.1	-	23	-	-
NH_3 (mg/l)	0.1-12.5	-	22	-	-
Soluble PO_4 (mg/l)	0.1-6.2	-	-	-	-
P (mg/l)	-	2.8	-	-	-
Total Coliforms (no./100 ml)	$20,000-90X10^6$	-	11,000[5]	-	-
Fecal Coliforms (no./100 ml)	$20,000-17X10^6$	-	-	-	-
Fecal Streptococci (no./100 ml)	$20,000-2X10^6$	-	-	-	-
Oil and Grease (mg/l)	-	-	2.4	-	50-180

NOTE: Abbreviations are as follows: 5 Day Biological Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and Total Solids (TS).

Source:
(1) "Management and Control of Combined Sewer Overflows," R. Field and E.J. Strinzeski, Jr., J. Water Pollution Control Federation, 44, 7, July 1, 1972.

(2) Engineering Report on Combined Sewer Study for Erie, Pennsylvania, prepared by Dalton, Dalton & Little, Inc., January 1972.

(3) Longterm average of highly infiltrated sanitary sewage flow; CS03.

(4) "Final Deposition of the Wastewaters of the City of Montevideo," prepared for the Municipality of Montevideo by Engineering Science, Inc., 1972.

(5) Considered an unreliable measurement.

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Table 2-345

Estimated Overflows from Combined Sewer Systems in the Regional Study Area

Muncipality	System Description	Estimated Average Annual Volume of Overflow (Millions of Gallons)	Receiving Water Body	Future Plans
Girard Borough(1)	Some combined and infiltrated sewers	0	-	-
Albion(1)	Separate system with infiltration problems.	42	Conneaut Creek Drainage Basin 4	Expansion of the treatment plant is planned and bypasses will be eliminated. Construction is expected to be completed by December, 1978
Conneaut City(2)	Entire system (serving 2,215 acres) suffers from infiltration	N/E	Conneaut Creek Drainage Basin 4	Hall Associates has recommended that the two undersized pumping stations be upgraded and that *the infiltrated system* be rehabilitated.
Ashtabula City	Combined sewers serving entire city	50(3)	Ashtabula River Drainage Basin 2	Bypasses will be eliminated when the sewer system becomes regional.

(1) Personal Communication, Hill & Hill, Inc.; also Erie County Storm Drainage Plan, 1974.

(2) Personal Communication, Hale Associates; also the Preliminary Plan Development and Environmental Assessment prepared for the City of Conneaut by Hale Associates, February, 1974.

(3) Estimate by Mr. Hubart Lloyd, Ashtabula Sewage Treatment Plant Operator.

N/E = Not Estimated.

Source: Arthur D. Little, Inc. estimates.

Table 2-346

Estimated Average Quality of Combined Sewer Overflows in Albion, Conneaut, and Ashtabula

Total Suspended Solids (mg/l)[1]	300
BOD_5 (mg/l)	100
COD (mg/l)	120
Total Coliforms (no./100 ml)	75,000
Total P (mg/l)	3
Total N (mg/l)	15

(1) One mg/l is equivalent to 8.33 lbs per million gallons.

Source: Arthur D. Little, Inc. estimates.

Table 2-347

Quality of Urban Stormwater Runoff

(1) Constituents	Approximate Range	Predicted Values			Means for Various Study Areas											
		Costs of Sprawl	Upper Allegheny River Basin Commp Study	For a residential-light commercial area (Ref. 1)	Windsor, Ontario (Ref. 2)	Windsor, Ontario (Ref. 1)	Cincinnati (Ref. 3,4)	Oxbey, England (Ref. 5)	Ottawa (Ref. 6)	Seattle (Ref. 7)	Stockholm (Ref. 8)	Durham, N.C. (Ref. 9)	Tulsa (Ref. 10)	Washington D.C. (Ref. 11)	Lubbock, Texas (Ref. 12)	Lawrence, Kansas (Ref. 13)
BOD	0-7700	23.3	40.	15.	20.5	12	17	7	21	10	13	14.5	11.8	19	25	-
COD	25-3100	63.0	140.	150.	-	-	111	-	-	-	-	179	85.5	335	-	-
Total Col.	.004-2400	1.2	-	200.	64.	2400	58[2]	-	-	4.4	-	-	87[3]	600	-	-
Fec. Col	.1-2000	-	-	12.	8.2	8.8	10.9[2]	-	-	-	-	30	0.42[3]	310	-	-
Fec. Strep.	5-25	-	-	15.	-	-	20.5[2]	-	-	-	-	-	6[3]	21	-	-
NO_3	.5-1.6	-	0.5	1.3	1.16	1.4	-	-	1.3	1.55	-	-	-	-	3	-
NO_2	.001-.370	-	-	0.10	0.066	0.09	-	-	0.16	-	-	-	-	-	-	-
NH_3	-	-	-	0.08	0.054	0.087	-	-	-	-	-	-	-	-	-	-
Inorg. N	-	-	-	-	1.28	1.58	1.0	-	-	-	-	-	-	-	-	-
Org. N	-	-	-	1.50	-	-	2.1	-	-	2.07	-	-	0.85	-	-	-
Total N	-	2.7	3.0	-	-	-	3.1	-	-	-	1.5	-	-	2.1	-	-
Ortho PO_4	0-2.5	-	-	0.80	0.437	0.98	-	-	1.2	0.22	-	-	1.15	-	-	-
Total PO_4	-	0.8	0.8	1.6	-	-	1.1	-	-	0.67	0.26	1.78	-	1.3	-	-
SO_4	1-220	-	-	90.	46.0	106	-	-	94	-	-	-	-	-	-	-
( )	0-10,260	-	-	80.	72	110	12	-	-	-	168	7.6	11.5	-	-	21
TS	30-36,250	-	3,640.	-	-	-	-	-	384	-	-	2730	545	2106	900	1180
TSS	16-36,250	1000	650.	300.	279	305	227	194	150	-	122	-	367	1697	530	974
VSS	-	-	-	100.	112	59	57	-	-	-	80	-	-	145	145	-
Turbidity	50-1200	-	-	200.	363	134	176	-	-	230	-	-	-	-	-	-
Color	-	-	-	150.	160	220	87	-	-	90[4]	-	-	-	-	-	-
pH	6.75-8.05	-	-	7.4	7.40	7.35	7.5	-	-	-	-	-	7.4	6.5	7.4	7.7
Sp. Cond.	0.65-2.39	-	-	0.30	0.35	0.58	-	-	-	-	-	-	0.108	-	-	-
Total Alk.	40-345	-	-	90.	115	106.	-	-	-	-	-	-	-	-	93	-
Total hard.	50-505	-	-	150.	151	211.	81	-	-	-	-	-	-	-	-	-
Ca hard.	100-150	-	-	-	100	144.	-	-	-	-	-	-	-	-	-	-
G. and oil	8.9-70	-	-	30.0	18.7	-	-	-	19	67	47	-	-	-	-	-

All notes and references on following pages.

Notes For Table 2-347

(1) The following abbreviations and notes apply. Nitrates (NO_3), nitrites (NO_2), ammonia (NH_3), inorganic nitrogen (inorg. N), organic nitrogen (org. N), and total nitrogen (Total N) are all reported as N. Orthophosphates (Ortho PO_4) and total phosphorus (Total PO_4) are reported as PO_4. Sulfates (SO_4) are reported as SO_4. Chlorides (Cl) are reported as Cl. Total hardness (Total hard.), total alkalinity (total alk.) and calcium hardness (C_a hard) are reported as CaCO. All the preceeding values are reported in mg/l. Also BOD, COD, TSS, volatile suspended solids (VSS), total solids (TS), and grease and oil (G. and oil) are reported in mg/l.

Total coliforms (total col.). fecal coliforms (fec. col.) and fecal streptococci (fec. strep.) are all reported as (counts X 10^{-3})/100 ml. Turbidity is reported in JTU. Color is reported in color units. Specific conductance (sp. cond.) is reported in millimhos/cm. pH is reported as $\log_{10}$ (H+); the arithmetic averages of pH are reported.

*Values for rainfall only (snowmelt excluded)

(2) Fifty percent of samples exceed this value.

(3) Geometric mean.

(4) Median values.

Source: Arthur D. Little, Inc., estimates, partial compilation by Droste and Hartt, 1975.

References For Table 2-347

Ref. 1 Droste, R.L. and J.P. Hartt, "Quality and Variation of Pollutants Loads in Urban Stormwater Runoff," Canadian Journal of Civil Engineering, Volume 2, Number 4, 1975. pp 418-429.

Ref. 2 Singh, M.M., 1972, "Urban Storm Runoff: A Qualitive and Quantitative Study," M.S. Sc. Thesis, Univer. Windsor, Windsor, Ont.

Ref. 3 Weibel, S.R., 1969, "Urban Drainage As a Factor in Eutrophication. Euthrophication: Causes, Consequences, Correctives Proc. Int. Symp. Euthrophication, Nat. Acad. Sci. Wash., D.C. pp. 383-403.

Ref. 4 Weibel, S.R. Weidner, R.B. Christianson, A.G., and Anderson, R.J. 1966. Characterization, Treatment and Disposal of Urban Stormwater. Proc. 3rd Int. Conf. Water Pollut. Res. Water Pollut. Control Fed., Wash., D.C. pp. 1-15.

Ref. 5 Wilkinson, R., 1956, "The Quality of Run-Off Water from a Housing Estate," J. Inst. Public Health Eng. Lond. Eng., pp. 70-84.

Ref. 6 Warnock, R.G., 1971, "A Study of Pollutional Loadings from Urban Storm Runoff," Proc. 6th Can. Symp. Water Pollut. Res. Toronto, Ont.

Ref. 7 Sylvester, R.O., and Anderson, G.C. 1964, "A Lake's Response to its Environment," J. Sanitation Eng. Div., Proc. Am Soc. Civ. Eng. 90(SA1). pp. 1-21.

Ref. 8 Soderlund, G., and Lehtinen, H., 1972, Comparison of Discharge from Urban Storm-Water Runoff, Mixed Storm Overflow and Treated Sewage, Proc. 6th Int. Water Pollut. Res. Conf., Pergamon Press Ltd., Lond. Eng.

Ref. 9 Bryan, E.H., 1971, Urban Stormwater Quality and Its Impact on the Receiving System, Proc. 20th South. Water Resour. Pollut Control Conf. North Carolina, Chapel Hill, N.C., pp 38-51.

Ref. 10 Avco Economic Systems Corp, 1970, "Storm Water Pollution from Urban Land Activity," Final Project Report Contract No. 14-12-187. Fed. Water Qual. Adm. U.S. Dep. Inter., Wash. D.C. pp 1-4,7,94.

Ref. 11 DeFillippi, J.A. and Shih, C.S., 1971, "Characteristics of Separated Storm and Combined Sewer Overflows," J. Water Pollut. Control Fed. 43(10). pp. 2033-2058.

Ref. 12 Brownlee, R.C. Austin, T.A., and Wells, D.M., 1970, "Variation of Urban Runoff with Duration and Intensity of Storms," Water Resour. Cent., Texas Tech. Univer. Lubbock, Texas p.31.

Ref. 13 Angino, E.A. Magnuson, L.M. and Steward, G.F., 1972, "Effects of Urbanization on Storm Water Quality: a Limited Experiment, Naismith Ditch, Lawrence, Kansas, Water Resour." Res 8(1). pp. 135-140.

Table 2-348

Pollutant Loading Factors for Urban Land Use
(pounds/acre/year)

Constituents	Industrial	Commercial	Residential	Institutional and Public
Total Solids	7100	3400	7100	7100
BOD_5	140	200	140	140
COD	100	900	100	100
Total P(1)	7	3	7	7
Total N(2)	40	20	40	40
Fecal Coliform(3)	$5X10^{12}$	$2X10^{12}$	$5X10^{12}$	$5X10^{12}$
Zinc	2	2	2	2
Copper	0.7	0.4	0.7	0.7
Lead	6	10	6	6
Iron	150	70	150	150
Chromium	1	0.7	1	1
Cadmium	0.02	0.01	0.02	0.02

(1) Of which approximately 30% are found as orthophosphates.

(2) Distributed approximately as:

NO_3 nitrogen	3.5%
NO_2 nitrogen	0.5%
NH_4 nitrogen	39.4%
Organic nitrogen	56.6%

(3) Colonies per acre per year

Source: Arthur D. Little, Inc. estimates, based on U.S. Environmental Protection Agency, 1975, Water Quality Management Planning for Urban Runoff.

shown in Table 2-349. The total amounts of livestock wastes produced in Erie, Crawford, and Ashtabula Counties are shown in Table 2-343. Cattle are estimated to be the greatest contributors of the listed contaminants, due to both the high wastes production rate and their large population. The estimated annual contaminant loading (tons per year) to each drainage basin from livestock wastes was shown previously in Table 2-343. In developing those figures, the total potential loadings (refer to Table 2-350) were apportioned to each drainage basin on the basis of the amount of agricultural land in that drainage basin. In addition, it was assumed that 10 percent of the major contaminants and 0.5 percent of the fecal coliforms reach surface waters.(2-165) The calculations indicate that the greatest loadings from livestock wastes reach the Conneaut Creek and Pymatuning Reservoir drainages.

Runoff From Nonurban Lands

2.632

Due to the rural nature of the Regional Study Area, runoff from nonurban land is a primary contributor of contaminants to local water bodies. In general, the major contaminant in nonurban runoff is sediment resulting from soil erosion. As discussed earlier erosion rates are greatest on bare, steep land. In terms of land use, erosion from forested land is generally light, erosion from pastureland somewhat heavier, and erosion from cropland heavier still. Erosion rates from construction sites are generally greatest. In addition to sediment, a variety of other contaminants may be found in runoff from nonurban land. Chemicals occurring naturally in the soil, including nitrogen, phosphorus and potassium, are also found in runoff, often in relative concentrations (with respect to sediment) two to three times greater. Runoff from cropland may carry a heavy organic load from crop residues and may thus exert a high BOD. Chemicals applied by man to the vegetation or soil are also found in runoff. Some soils in the Regional Study Area are acidic and low in plant nutrients and must be limed and fertilized to yield well. Runoff from fertilized land will have elevated concentrations of nitrogen, phosphorus, and potassium. If the land or vegetation has additionally been treated with insecticides, fungicides, herbicides or rodenticides, then these too may eventually find their way into the runoff. Contaminant loadings to local surface waters in the Regional Study Area from nonurban lands were estimated based on runoff data obtained in 1977 at Turkey Creek (refer to Table 2-351). These calculations were made assuming a runoff coefficient and a sediment delivery ratio of 0.3 and 0.67, respectively, for the upstream section of the Turkey Creek drainage basin, a sediment delivery ratio to local surface waters of 1.0 and an average annual precipitation in the Turkey Creek drainage basin of 35 inches. All contaminant loadings were assumed proportional to the solids loadings. Since the land use mixture in the Turkey Creek drainage basin is a typical

Table 2-349

Livestock Conversion Factors

Type of Livestock	BOD	SS	N	P	Fecal Coliform Number Per Day Per Animal
	Pounds Per Animal Per Day				
Cattle	2.46	9.61	0.865	0.061	5.4×10^9
Horses	1.70	6.62	0.397	0.042	3.7×10^9
Sheep	0.37	1.44	0.086	0.009	8.0×10^8
Hogs	0.29	1.11	0.062	0.009	8.9×10^9
Chickens	0.02	0.08	0.009	0.0013	2.4×10^8

Source: "Waste in Relation to Agriculture and Forestry," U.S. Department of Agriculture, 1968, as cited in "Comprehensive Water Quality Management Plan for the Pennsylvania Portion of the Lake Erie Drainage Basin and the Remaining Portion of Erie County," Pennsylvania Department of Environmental Resources, 1976.

Table 2-350

Total Livestock Wastes Produced

	BOD (Tons/Yr)	SS (Tons/Yr)	N (Tons/Yr)	P (Tons/Yr)	Coliforms (MPN/Yr $\times 10^{12}$)
Ohio					
Ashtabula County[(1)]	24,512	95,764	8,511	627	130,853
Pennsylvania					
Erie County[(2)]	18,179	71,029	6,321	469	92,670
Crawford County[(3)]	41,279	161,302	14,440	1,055	204,188

(1) Calculated from Ohio Agricultural Statistics, Ohio Corp Reporting Service, 1977.

(2) "Comprehensive Water Quality Management Plan for the Pennsylvania Portion of the Lake Erie Drainage Basin and the Remaining Portion of the Erie County, Pennsylvania Department of Environmental Resources, 1976.

(3) Calculated from Pennsylvania Dept. of Agriculture Crop and Livestock Summary.

Table 2-351

Estimated Runoff Loadings of Selected Contaminants
(pounds/acre/year)

	Commerical Land[1]	Other Urban Land[1][2]	Rural Land[3]
Total Solids	3400	7100	2700
Total Nitrogen	20	40	3
Total Phosphorus	3	7	1.5[4]
BOD_5	200	140	25
COD	900	100	230
Fecal Coliform(col/liter)	$2x10^{12}$	$5x10^{12}$	$2x10^{6}$
Zinc	2	2	0.6
Copper	0.4	0.7	.04
Lead	10	6	0.1
Iron	70	150	20
Chromium	0.7	1	0.04
Cadmium	0.01	0.02	0.04

(1) Based on nationwide data.

(2) Excludes industrial lands. Pollutant loadings of industrial lands has been observed to be highly variable.

(3) Estimated from runoff data obtained in 1977 at Turkey Creek. These loadings were applied to the combined category of "agricultural land" plus "other rural land".

(4) PO_4 phosphorus only.

Source: Arthur D. Little, Inc., estimates, "Water Quality Management Planning for Urban Runoff," Environmental Protection Agency, EPA-440/9-75-004, Washington, D.C., and Appendix E.

rural mixture for the (Coastal) communities, runoff from this basin is considered representative of runoff from other rural areas in the Regional Study Area. However, these runoff data were obtained over a brief time frame; and hence, are of limited reliability. The Turkey Creek runoff data indicates that nutrient loadings (nitrogen, BOD, and phosphorous) in this area are relatively low compared to nationwide averages. (2-166,167,168,169,170,171,172) Solids loadings appear typical.

Runoff from Other Sources

2.633

A major water pollution problem in Pennsylvania is caused by drainage from coal mines. (2-165) Due to the lack of coal mining activity in Ashtabula, Erie, and Crawford Counties, this problem is minimal in the Regional Study Area, if it exists at all. However, runoff from the large number of sand and gravel surface mines located in the Regional Study Area is expected to contain a high level of suspended solids. The available data are insufficient to estimate the loadings to local surface water from this source. Road drainage containing high concentrations of de-icing compounds constitutes another non-point pollution source. Road drainage is actually a form of urban runoff; however, de-icing compounds were not considered explicitly in the urban runoff section. Common salt (sodium chloride) and calcium chloride are the chemicals commonly used to control snow and ice on roadways. Calcium chloride is more effective at lower temperatures; but is used infrequently due to high cost. National studies (2-173) indicate that a typical application of salt ranges from 200 pounds to 400 pounds per lane mile (2-173). During a winter season, several States apply as much as 20 tons per lane mile, with toll road authorities using the greatest applications. Chloride concentrations in runoff from treated roadways may be typically around 15,000 ppm and as high as 25,000 ppm. (2-173) Associated with the use of salt for snow and ice control is the use of ferric ferrocyanide (prussian blue) which is added to salt to prevent caking. Prussian blue is insoluble in water, and thus its contribution to water pollution is limited. However, the compound sodium ferrocyanide (yellow prussiate of potash) can also be used to prevent salt caking. This compound is soluble in water, and can lead to the release of cyanide in the presence of sunlight. In the Regional Study Area, application of de-icing compounds to State roads are fairly heavy whereas applications to Ashtabula county roads are lower (refer to Table 2-352). Calcium chloride may be used in some localities, and it is applied in liquid form to the truck-loaded salt by the State of Ohio DOT. Some calcium chloride was used by Springfield Township until its cost became prohibitive. (2-174) The city of Conneaut uses only salt (no sand) to melt snow and ice, because they have no facilities to mix the two. (2-175) On a "per mile" basis, their applications tend to be low.

Table 2-352

Annual Road Treatments in the Regional Study Area

	Salt		Sand		CaCl		Cinder	
	Tons/Mile	Total Tons	Tons/Mile	Total Tons	Tons/Mile	Total Tons	Tons/Mile	Total/Tons
Ashtabula County Roads(1)	5.5	2,162	8.8	3,118	UK(2)		0.85	301
State Roads(3) in Erie County	55.0	30,000	1,155	84,000	UK(2)		0	0
State Roads in Ashtabula County(4)	77.0	25,700	0	0	24	8,200	0	0
City of Conneaut(5)	3.3	1,800	0	0	UK(2)		0	0

(1) Averages for the 1965-1972 period as obtained from the Ashtabula County Engineer's Annual Reports. The values obtained from these reports were total loadings. These were divided by the 393 miles of Ashtabula County roads to obtain the average tons applied per mile. (The figure 393 includes 38 miles of gravel roads).

(2) Unknown.

(3) These estimates were calculated assuming 120 applications per winter season with 250 pounds of salt and 700 pounds of sand applied per land mile per application. Erie County contains approximately 2000 lane-miles of state roads, or equivalently, 543 miles of state roads. (Personal Communication, Mr. Caluim Heine, Pa. DOT Maintenance, March 29, 1977.)

(4) Data for 1976-1977 Winter Season. (Personal communication, Mr. Ed Miller, Ohio DOT Maintenance, August 4, 1977.)

(5) Data for the 1976-1977 Winter Season (Personal communication, Mr. Ed Penfield, Street Commissioner of the City of Conneaut, August 5, 1977). They also used 6 barrels of a liquid salt additive. There are approximately 550 miles of roads in Conneaut, of which less than 25% are paved.

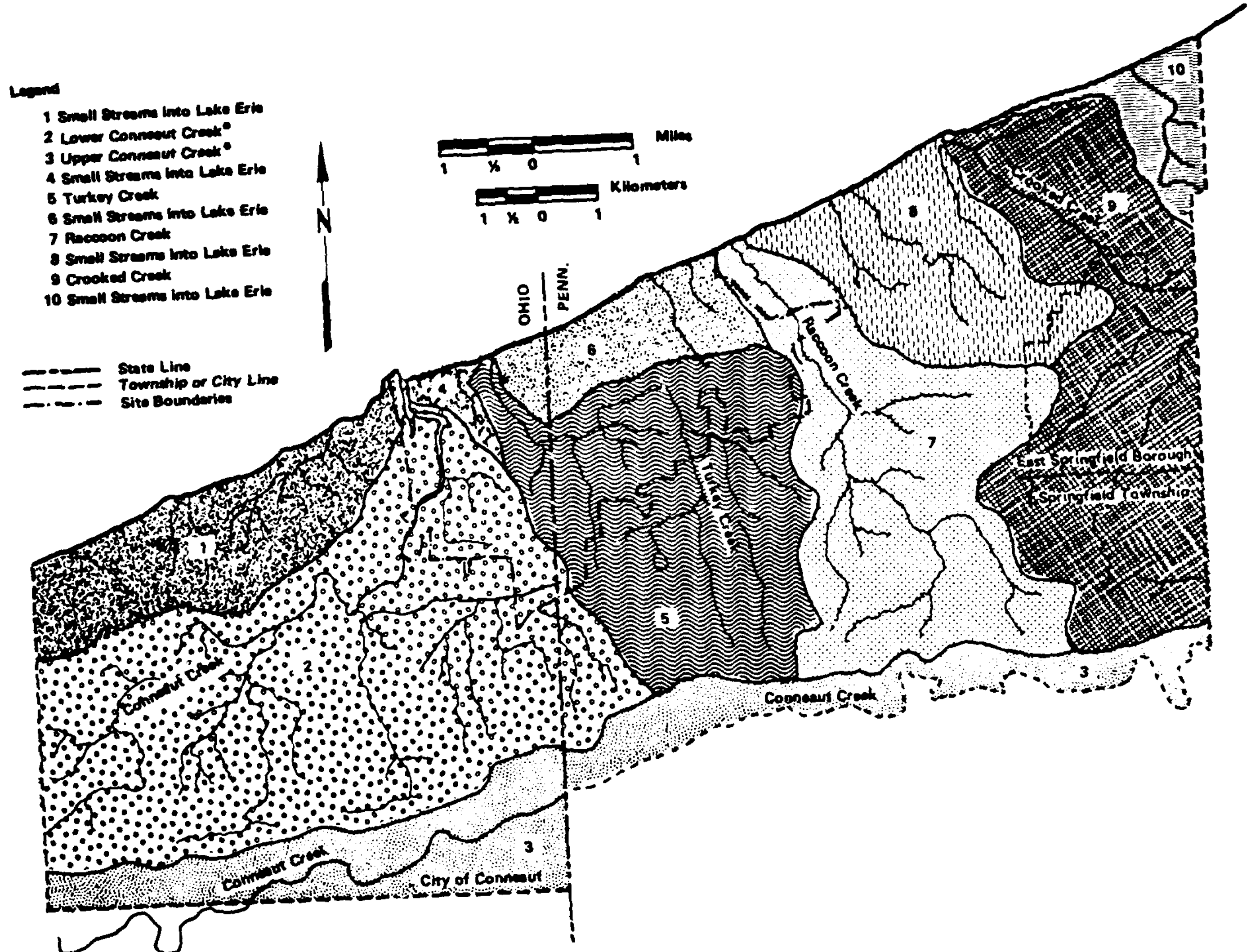
e) Stormwater Runoff on the Proposed Project Site

Quantity and Dynamics

2.634
The drainage basins in the vicinity of the project site are indicated in Figure 2-120. At this time, most of the stormwater runoff from the proposed project site drains into Turkey Creek and thence into Lake Erie. However, recent construction along the Conrail Line has altered this drainage pattern somewhat and some land originally draining into Turkey Creek now seems to be draining into Conneaut Creek. Portions of the Raccoon Creek drainage basin and the Conneaut Creek drainage basin are also contained on the site, and approximately 25 percent of the site drains directly into Lake Erie via overland flow or other small streams. Due to predominantly flat topography and relatively impermeable soils, most of the project site drains poorly. Pools of standing water can still be observed days after a storm event. Pooling is primarily a problem in those relatively flat areas surfaced by soils derived from lacustrine deposits or glacial till. The strand deposits, alluvial deposits and fill deposits and their associated soils are of varying permeabilities, depending on the grain size of the constituents. Those deposits with relatively high percentages of gravel and sand tend to allow stormwater to drain through them more easily. The areas of the project site that are steeply sloped (such as the stream banks, the shoreline bluffs and some portions of the site under construction) tend to have extremely high runoff coefficients (runoff to rainfall ratios) due to the combination of steep topography and impermeable soil conditions. High velocity runoff flows will be observed in these areas during storm events, usually resulting in gullying and sheet erosion, especially where vegetation is sparse.

Quality

2.635
Much of the project site is either wooded land, shrub growth or open land. However, other portions are currently undergoing industrial usage (including the raw materials storage pile areas operated by the P&C Dock Company) or construction for such usage. Runoff from these areas is of a notably different quality than runoff from typical rural land. Currently, runoff from the P&C Dock Company docks and storage piles is released to Conneaut Creek and to Conneaut Harbor via six or eight controlled discharge points. (2-176) However, engineering plans are currently being developed by the Dock Company to provide improved runoff collection in accordance with Ohio EPA guidelines. As presently formulated, the plans call for one retention basin (in which acidic coal runoff and basic limestone runoff will partially neutralize each other) and one discharge point.



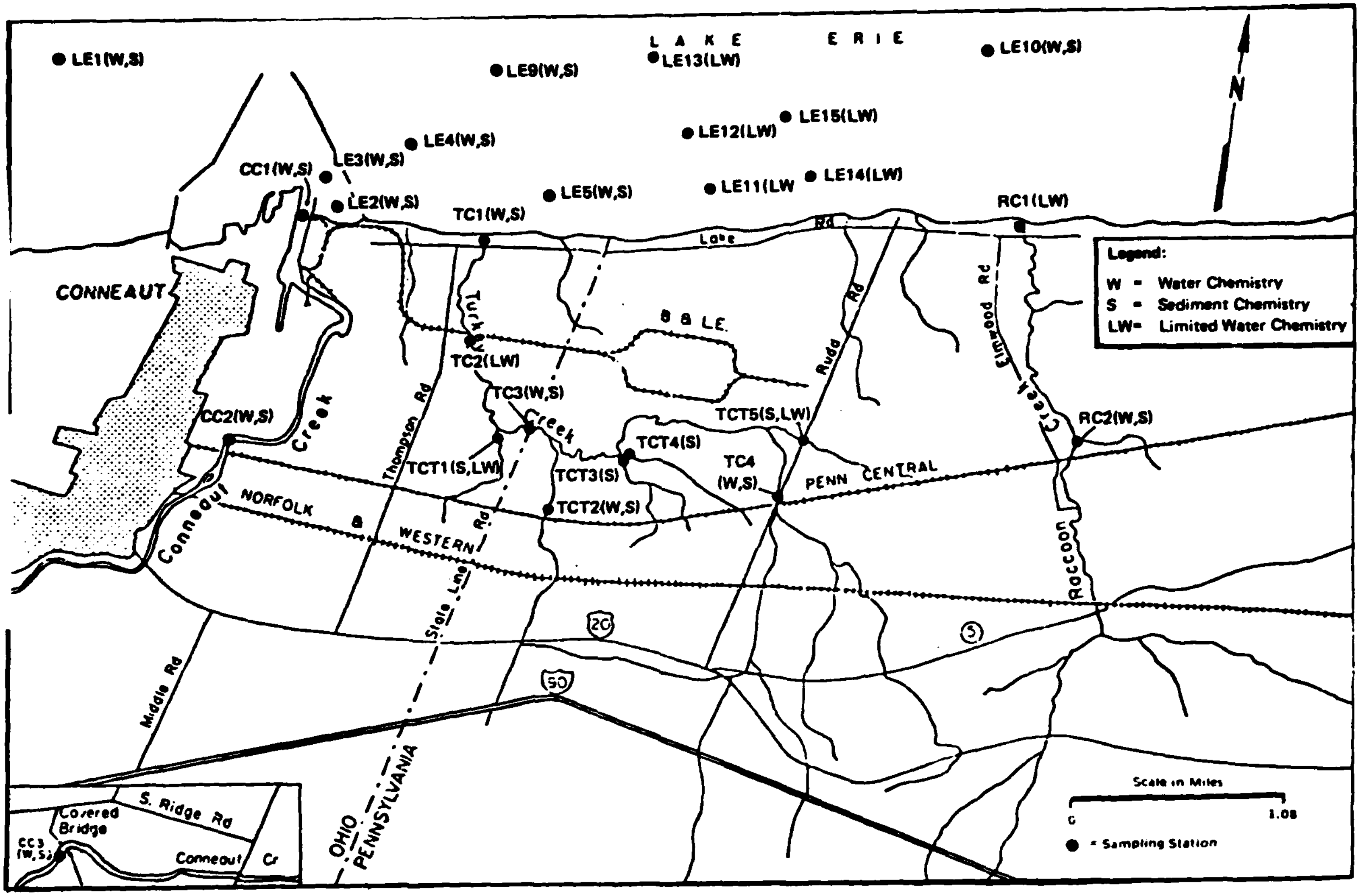
*For clarity, the divide between the upper and lower reaches of Conneaut Creek is shown. This is not to imply that the water quality in these two sections is significantly different.

Source: Arthur D. Little, Inc. estimates.

FIGURE 2–120 DRAINAGE BASINS IN THE LOCAL STUDY AREA

Construction of the new system is expected to be completed by the year 1978. When completed, runoff from approximately 150 acres of docks and storage areas will enter the collection system at an average flow over the year of approximately 0.4 MGD. The location of the discharge point is not yet known, but would require approval by the Ohio EPA. If treatment were required the effluent would be treated by the Conneaut City Sewage Treatment Plant or by the Dock Company prior to discharge. (2-176) At present, runoff from the construction areas on the site is visibly muddied, indicating high suspended solids levels. Soil erosion in these areas is fairly severe with erosion rates probably as great as 200 tons/acre-year on some of the steeper inclines. Some of this eroded material is carried in the stormwater runoff to Conneaut Creek.

2.636
Further insight into the quality of stormwater runoff from the project site can best be obtained through an analysis of the available field measurements. Surface water quality data for Turkey Creek during a storm event has been obtained by the Erie County Health Department, and their results are presented here in Table 2-353. It should be noted that 0.34 inches of rain fell the day before these measurements were taken. However, the small size of the Turkey Creek basin will tend to minimize the effect of this size storm event after 24-hours. This data has been analyzed in conjunction with similar data obtained by Aquatic Ecology Associates, Inc. during dry weather (refer to Table 2-354). The location of the sampling stations used in these studies are indicated in Figure 2-121. The storm event studied increased the flow rate in Turkey Creek by a factor of 3 to 5 over the flow rates observed at the same locations the previous week. Water temperatures were depressed (by approximately 10^{o}C) and dissolved oxygen levels were elevated, as would be expected. The concentrations of most chemical species (including Cl, total hardness, dissolved solids, BOD^5) were reduced by a factor of 1.5 to 2.5. However, given the difference in the flow rates of Turkey Creek on the two sampling days, the total flux of these chemical species exhibited a net increase. Suspended solids levels during the storm event were slightly depressed from those values observed during dry weather. This result probably indicates a trade-off between the increased sediment-carrying ability of the heavier flows and the greater influx of relatively clean water during the storm event. The concentration of certain chemical constituents such as zinc, lead, iron, nickel, and copper showed a net increase. These metals most likely occur primarily adsorbed on suspended solids carried in the water column, and their presence in greater concentrations during the storm event is probably due to the scouring ability of overland flow and the increased sediment-suspending ability of the creek itself as a result of increased flow rates. The concentrations of ammonia and nitrates were significantly elevated after the storm event, although



Source: Aquatic Ecology Associates.

FIGURE 2–121 LOCATION MAP OF STREAM AND LAKE WATER AND SEDIMENT CHEMISTRY SAMPLING LOCATIONS

Table 2-353

Surface Water Quality in Turkey Creek Following a Storm Event (1)

Station Number (2)	Flow (cfs)	Temp (°C)	Dissolved Oxygen (mg/l)	pH	Metals (3) Zn	Pb	Ni	Mn	Fe	Cu	Cr	Cd	Al	Cl	SO_4	Total Solids	Suspended Solids	Total Dissolved Solids	NO_2-N	NO_3-N	NH_3-N	Hardness	Ca (3)	Mg (3)	MBAS
12	1.01	8.7	9.5	6.70	20	<10	20	70.0	430	10	<10	<1	2850	31	22	180	4	176	0.01	0.48	0.180	72	21.6	4.6	1.0
13	2.05	8.3	11.1	7.45	20	<10	20	110.3	430	<10	<10	<1	2850	51	36	276	16	260	0.01	0.58	0.08	106	11.1	6.8	2.0
14	10.18	10.0	10.2	7.5	50	<10	20	70.0	500	<10	<10	<1	2850	44	34	268	8	260	0.01	1.25	0.1	106	30.5	7.3	2.0
15	8.29	9.0	11.0	7.65	30	<10	20	60.0	700	<10	<10	<1	570	38	30	260	28	232	0.01	0.96	0.08	94	27.1	6.3	1.0
16	5.94	13.3	10.1	7.35	20	<10	20	10.0	240	<10	<10	<1	285	12	22	128	2	126	0.01	0.02	0.05	56	16.0	3.9	1.0
18	27.50	11.0	11.2	7.45	20	<10	20	50.0	1320	10	<10	<1	1000	26	28	200	18	182	0.01	0.44	0.09	88	26.9	4.9	2.0
19	3.95	13.0	11.0	7.50	20	<10	20	70.0	2020	10	<10	<1	1140	33	28	244	64	180	0.01	0.18	0.140	84	26.0	5.9	2.0

(1) Concentrations given in mg/l except where indicated.
(2) See Figure 2-136 for station locations.
(3) Values given are g/l and represent total values.
Source: Erie County Health Department Measurements, April 27, 1977.

Table 2-354

The Effects of A Storm Event on Turkey Creek[1]

	Stations			
	TC-3 Dry Day	18 Storm Event	TC-4 Dry Day	15 Storm Event
Flow (estimated, cfs)	5.70	27.50	2.63	8.29
Temp. (°C)	19.8	11.0	22.0	9.0
Dissolved Oxygen (mg/l)	7.8	11.2	8.5	11.0
Specific Conductivity (μmhos/cm)	540.0	220.0	480.0	320.0
pH (units)	7.6	7.45	7.7	7.65
Color (pt-Co units)	70.0	35.0	70.0	35.0
Total Hardness	142.0	80.0	148.0	94.0
Cl	62.0	26.0	70.0	38.0
Suspended Solids	28.0	18.0	29.0	28.0
Dissolved Solids	287.0	182.0	306.0	232.0
NO_2-N	0.02	0.01	0.02	0.01
NO_3-N	0.21	0.44	0.30	0.94
NH_3-N	0.02	0.09	<0.02	0.08
Cu-Total	<0.01	0.01	<0.01	<0.01
Fe-Total	0.50	1.32	0.26	0.70
Ni-Total	<0.03	0.02	<0.03	0.02
Pb-Total	<0.03	<0.01	<0.03	0.01
Zn-Total	0.01	0.02	<0.01	0.03
BOD_5	2.6	2.0	2.6	1.0
Hg (μg/l)	<0.5	1.0	<0.5	1.0

All values in mg/l unless otherwise specified.

(1) See Figure 2-136 for station locations. Stations TC-3 and 18 are in close proximity as are Stations TC-4 and 15. Water quality parameters for Stations TC-3 and TC-4 were obtained by Aquatic Ecology Associates on April 21, 1977. Flow parameters: for these stations were estimated by AEA on April 20, 1977 (TC-3) and April 21, 1977 (TC-4). Data for Stations 15 and 18 were obtained by the Erie County Health Department on April 27, 1977.

Source: Erie County Health Department; Aquatic Ecology Associates.

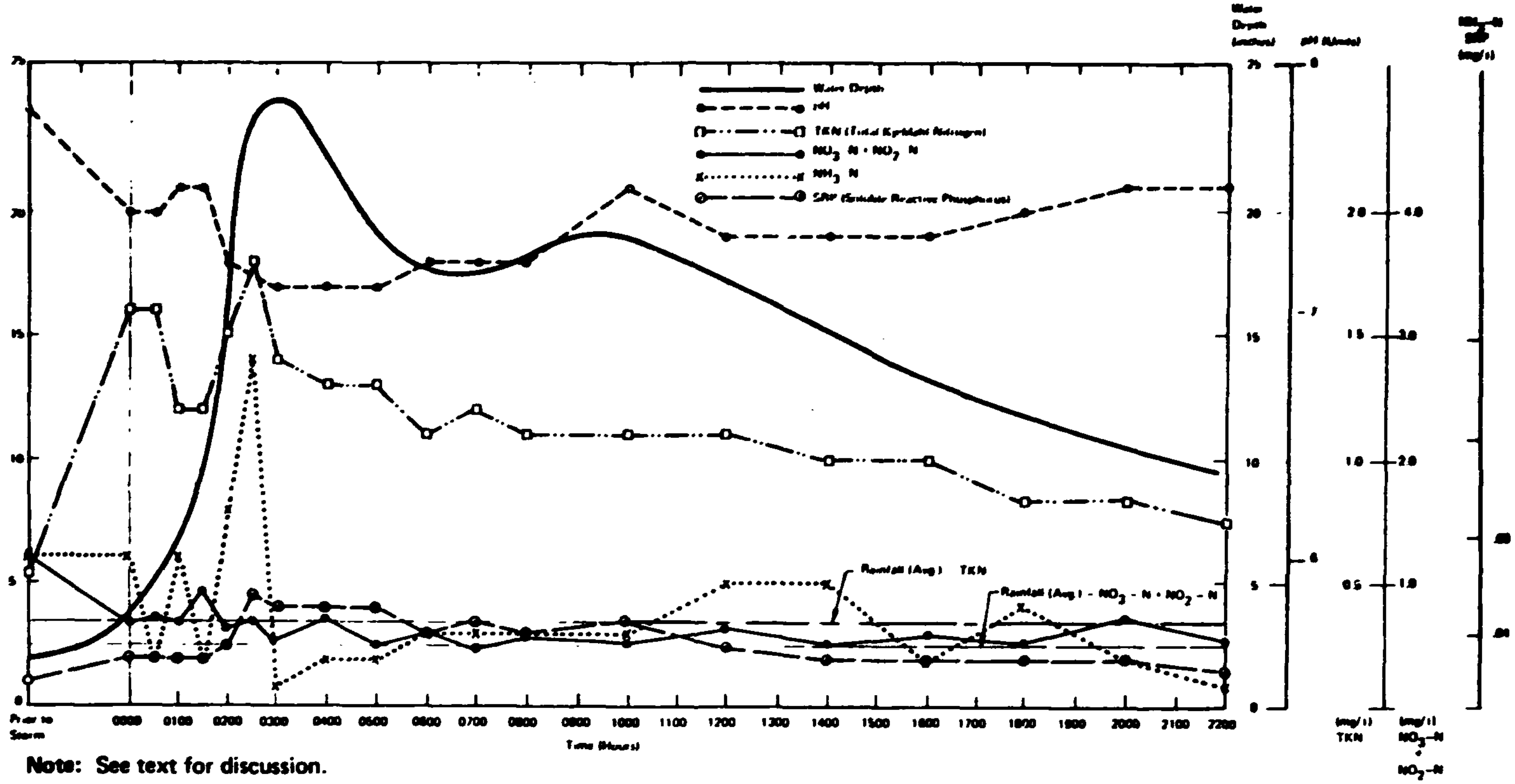
the nitrate level was halved. One possible explanation for this phenomenon is the presence of both of the former constituents in rainfall, with typical concentrations of about 1 mg/l.

2.637
The variation in surface water quality across the site after the storm event (refer to Table 2-353) indicated to a certain extent, the influence of land use on the quality of stormwater runoff. One would expect that runoff from the construction areas on the Penn Central Railroad right-of-way would contain elevation concentrations of suspended solids and heavy metals. Only the tributary from which the station 19 samples were taken passed through such areas, and as expected, the water samples obtained at this station show exceptionally elevated iron and suspended solids levels. It is possible that railroad drainage entering upstream has influenced the quality of the surface water sampled Stations 13 and 14 (as compared to that sampled at Station 12). Similarly, the absence of heavy woodlands in this part of the drainage basin might be exerting a noticeable effect on the quality of the water sampled at Station 16. However, the flow velocity and discharge rate can have a great effect on surface water quality (by influencing the sediment-carrying ability of stream), thus masking the influence of the quality of the entering stormwater runoff. Additional runoff data have been obtained on the Lakefront site by Penn Environmental Consultants, Inc. In their study, three entire storm events were monitored at the TC-4 station. The results of the 9/13/77 effort are graphically presented in Figures 2-122 through 2-124. Careful study of these newer and more complete data yield the following additional conclusions: rainfall quality strongly influences runoff quality with respect to acidity and phenols levels. (The average pH of rainfall ranged from 4.3 to 4.6; the average concentration of phenols in rainfall ranged from 0.015 to 0.019 mg/l) Some contaminants were not detected in the runoff, including cyanide (detection level of 0.005 mg/l), arsenic (detection level of 0.03 mg/l), and mercury (detection level of 0.5 ug/l). However, mercury levels of 1 ug/l were detected in Turkey Creek during the 21 April 1977 storm event.

f) Surface Water Quality

Lake Erie

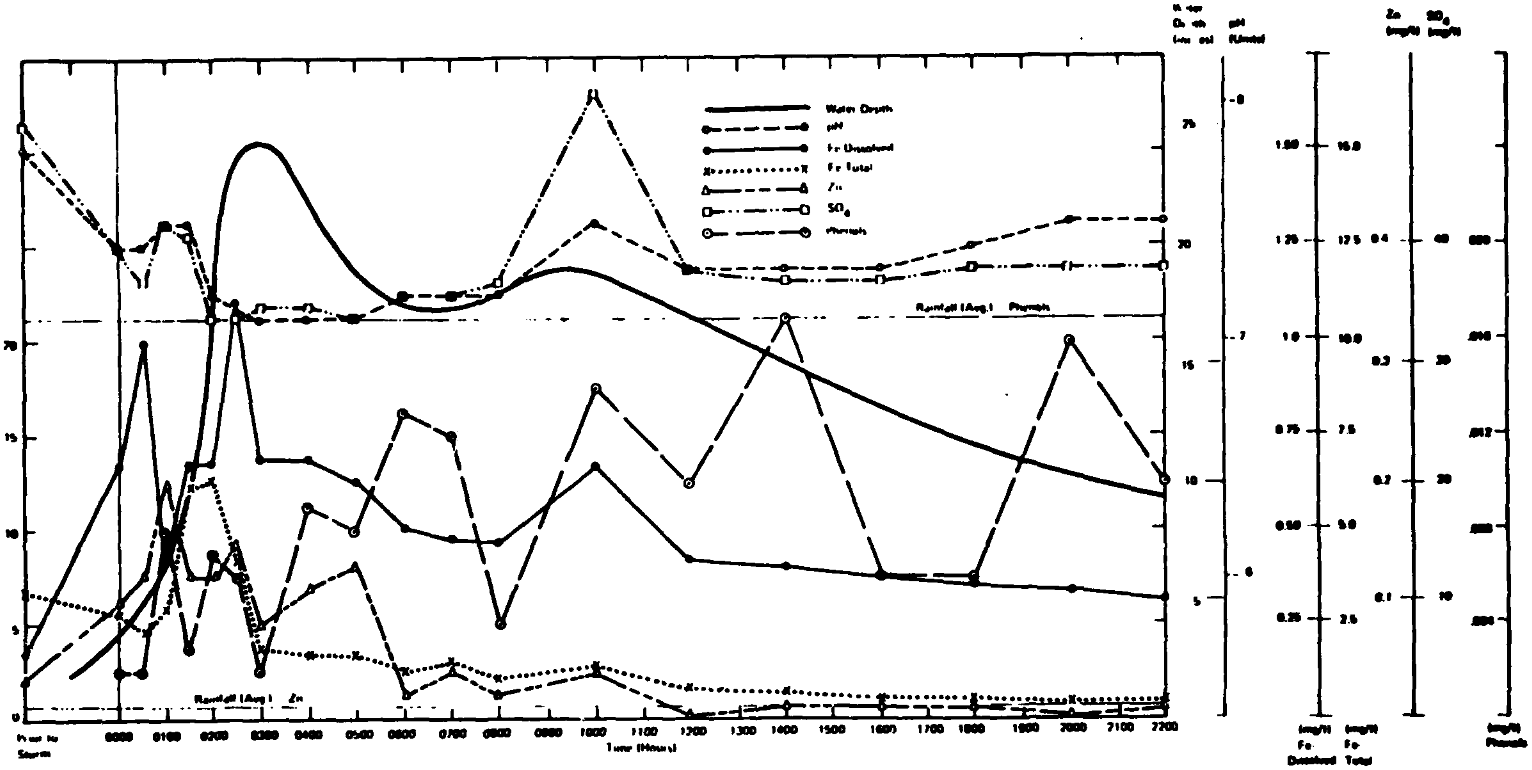
2.638
Topographically, Lake Erie is divided into three basins, the western, central, and eastern, as shown in Figure 2-125. The western-central boundary extends from Pt. Pelee to Sandusky Bay, and the central-eastern boundary extends roughly from Presque Isle to Long Point. The western basin is shallow, averaging seven meters while the central basin is slightly deeper, averaging 18 meters. The eastern



Note: See text for discussion.

Source: Penn Environmental Consultants

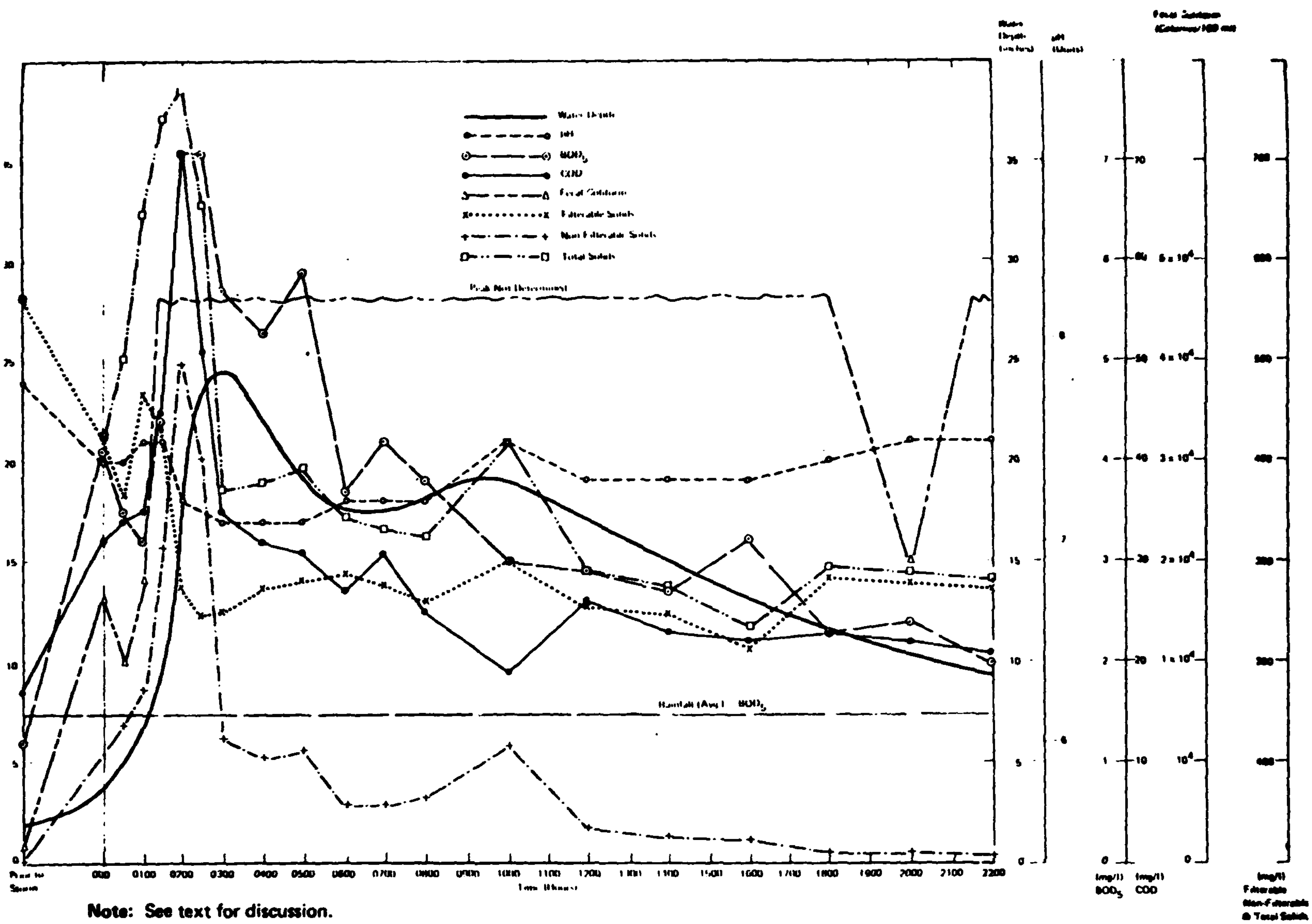
FIGURE 2–122 STORM FLOW QUALITY IN TURKEY CREEK (TC–4)



Note: See text for discussion.

Source: Penn Environmental Consultants

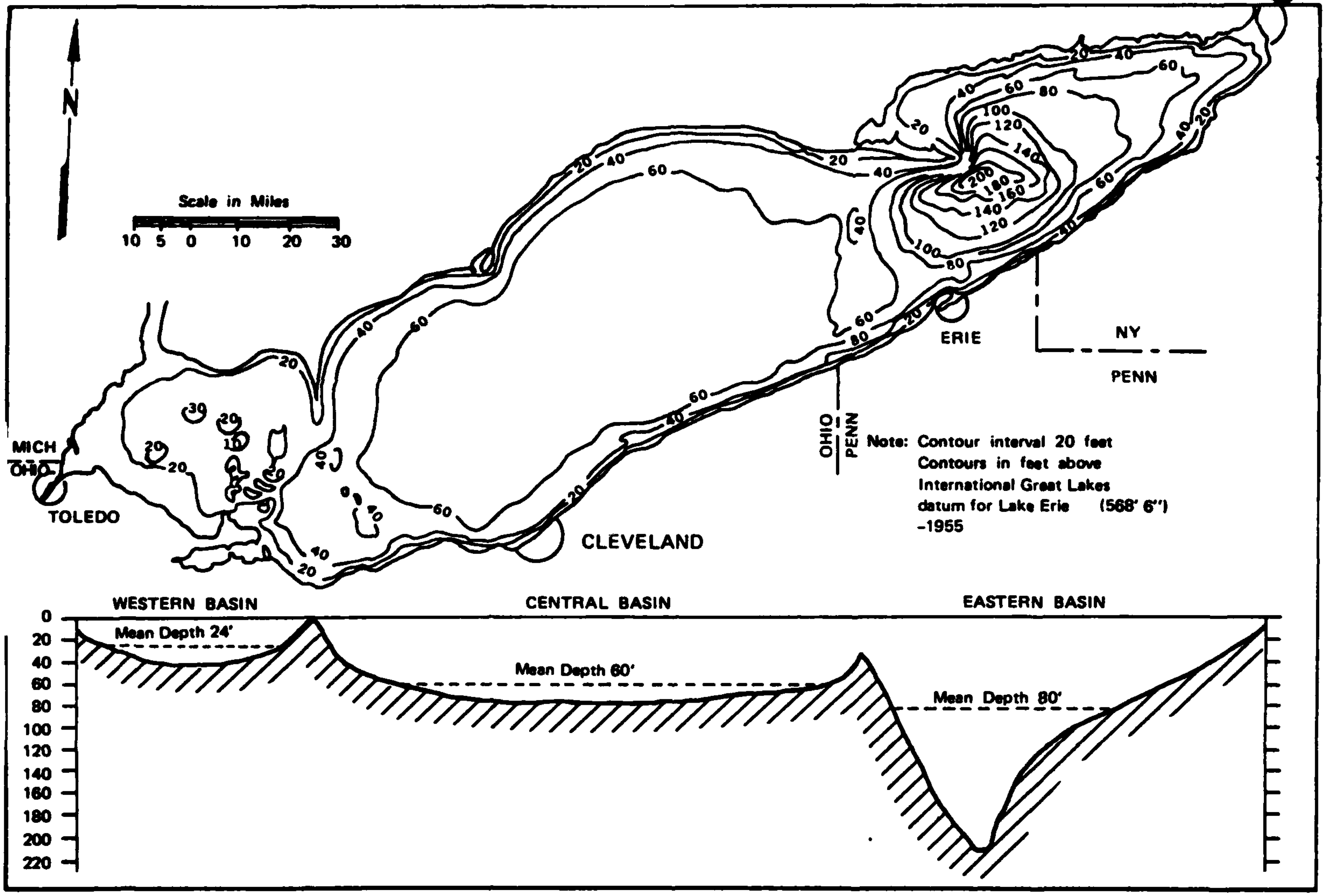
FIGURE 2–123 STORM FLOW QUALITY IN TURKEY CREEK (TC–4)



Note: See text for discussion.

Source: Penn. Environmental Consultants

FIGURE 2–124 STORM FLOW QUALITY IN TURKEY CREEK (TC–4)



Source: "Lake Erie Environmental Summary 1963–1974," U.S. Dept. of Interior, Federal Water Pollution Control Administration, Great Lakes Region, May 1968.

FIGURE 2–125 LAKE ERIE BOTTOM TOPOGRAPHY

basin averages 24 meters, and contains the deepest point in the lake, which is over 60 meters deep. The proposed plant site is on the south shore of the central basin, near its eastern terminus. The deepest connecting channel between the central and eastern basins, at about 18 meters depth, is located roughly 10 kilometers offshore of the proposed site. Much attention has been given to the development of anoxic conditions in the bottom waters of the central basin since severe dissolved oxygen (DO) depletion (0.5 ppm over more than 1,000 km was first observed in 1959. DO depletion threatens aquatic life, threatens the use of the lake as a public water supply, and is aesthetically displeasing when sulfide bearing waters upwell at the shoreline. Another reason for concern is the increased regeneration of chemicals, including phosphorus, from sediments when bottom waters are anoxic. A cooperative study by the USEPA and the Canada Centre for Inland Waters (CCIW) concluded that the cause of DO depletion in the central basin was increased production of algae and plankton caused by anthropogenic phosphorus inputs, and that a reduction of such inputs could reverse that process if such reduction were implemented quickly. (2-177) The direct input of oxygen demand has been shown to have little effect on offshore waters. Further, production of oxygen demanding organic material greatly exceeds man's direct input of oxygen demand.

2.639
Anoxic conditions develop during the summer when the lake is stratified and the cold bottom waters are effectively isolated from the warmer surface waters where oxygen concentrations are uniformly high. The western basin is too shallow to stratify for extended periods and wind stirring oxygenates the bottom waters. However, the central basin is just deep enough to support a stratified two-layer system. Anoxia develops first in the southwest part of the basin, near Sandusky Bay and the island area. (2-177) The only portion of the central basin hypolimnion (cold bottom waters) which has not become anoxic in recent years is the area offshore of Conneaut, which is replenished by oxygenated waters from the eastern basin hypolimnion. (2-178,179) The eastern basin waters remain oxygenated through the summer because of its greater depth and the greater volume of its hypolimnion. In the nearshore waters adjacent to the proposed site, DO concentrations were high in 1977, near saturation, as indicated in Table 2-355. Low values of dissolved oxygen have been reported from the Ashtabula Harbor and Presque Isle Bay. (2-180) Enclosed, dredged harbors are not as well mixed as the adjacent open waters of the lake. Compounding this problem is the fact that the harbors receive most municipal and industrial discharges, either directly or from streams.

2.640
The International Joint Commission Great Lakes Water Quality Board has identified certain water quality problem areas of Lake Erie.

Table 2-355

Lake Erie Baseline Water Quality Conditions for Selected Parameters[1]

	Typical	High	
Ammonia	0.04	0.3	
Arsenic[2]	0.001	0.005	
BOD_5	1.7	3.0	
Cadmium	0.001	0.005	
Chromium	0.005	0.010	
COD	10.0	25.0	
Copper	0.001	0.005	
Cyanide (A)[2]	0.0002	0.0005	
Dissolved Oxygen	11.0	15.0	(low 7)
Fluoride	0.13	0.20	
Iron (dissolved)	0.05	0.1	
Lead (total)	0.005	0.01	
Manganese (total)	0.01	0.02	
Mercury (total)	0.0001	0.0003	
Oil & grease	1.0	5.0	
pH, units	7.8	8.5	(low 7.0)
Phenols	0.0006	0.003	
Sulfide	0.002	0.010	
Total dissolved solids	200.0	250.0	
Total suspended solids	10.0	20.0	
Zinc	0.02	0.07	

(1) All values in mg/l except pH.

(2) Hypothetical estimate; all known analyses indicate less than the detection limit. Basis for estimate: typical value is 0.1 x detection limit; high value is 0.5 x detection limit. In addition, cyanide (A) is estimated to be 0.5 x cyanide (total).

Source: See text for a listing of the various sources used.

Some, like DO, are considered to be whole lake problems, others are geographically limited. Whole lake problems may not affect the *entire* lake in terms of water quality degradation, but their solution requires basin-wide control. Whole lake problems identified for Lake Erie are DO, nuisance growths of Cladophora, and contamination of fish by mercury and polychlorobiphenyls (PCB's). A report on PCBs in lake fish near Erie (2-181) confirms the Great Lakes Water Quality Board (2-180) report that Lake Erie fish exceed the Canadian guideline of 2 ug/g, but not the American guideline of 5 ug/g. Geographically-isolated problems in the vicinity of the proposed plant site are Ashtabula harbor where DO, fecal coliform, oil and grease, zinc, cyanide, chloride, and total dissolved solids exceeded OEPA standards in 1975; and Presque Isle Bay where DO, total coliforms, and fecal coliforms exceeded IJC criteria. Examination of STORET data shows that, over the last 10 years, pH, total dissolved solids, iron, total coliforms, and DO occasionally exceeded Pennsylvania standards in the open waters near Erie. IJC criteria for Cd, Hg, Pb, and Zn are often exceeded in the Pennsylvania waters of Lake Erie. In the Ohio waters of Lake Erie, extending from Ashtabula to the Pennsylvania State line, Ohio standards were occasionally exceeded for pH, hardness, oil and grease, COD, DO, Cu, SO, Cd, Mn, Fe, Ba, Pb, Ag, Hg, As, Zn, and Cl. The frequency and severiy of the excesses reported to STORET over the last 10 years are greatest for barium, silver, manganese, iron, sulfate, and cadmium.

2.641
Typical and extreme baseline water quality conditions of Lake Erie are presented in Table 2-355. In preparation of this table the following sources have been used: recent sampling data by Aquatic Ecology Associates at the proposed site; public water intake analyses from Erie, Conneaut, and Ashtabula; (2-182,183,184,185); STORET data; other published data including the CLEAR survey of 1973-1975, (2-178) International Lake Erie Water Pollution Board report of 1969, (2-179) and the Lake Erie Environmental Summary 1963-1964 of the Federal Water Pollution Control Association. (2-156) These sources have been weighted as to local, up-to-date validity in roughly the order listed. High ambient levels indicated in Table 2-355 do not always represent the highest recorded value. Instead the second highest or the average of the highest two or three recorded values was used. Often, extremely high values are suspected of being in error. For parameters whose value is below standard detection limits, an estimate has been made for calculation purposes to facilitate the impact analysis.

2.642
The recent trends in Lake Erie water quality can be detected primarily through whole lake sampling efforts, which have been conducted with increasing frequency since about 1960. Although Lake Erie is

the smallest of the Great Lakes, the flushing time, 2.7 years, is long in comparison to rivers and some smaller lakes. For this reason, and because of the large area of the watershed, a long series of observations are required to detect significant changes in the quality of the lake. The oldest quantitive measures of water quality relate to the major dissolved ions, which exhibit low toxicity but can be related to man's impact on the watershed. Analyses of calcium, chloride, sodium plus potassium, sulfate, and total dissolved solids observations from 1854 to 1968 showed that total dissolved solids, chloride, and sodium plus potassium concentrations were increasing rapidly, while calcium and sulfate indicated a leveling off since about 1950. (2-186) All had increased significantly over 1854 levels by 1920. Another significant trend in recent years is the rapid increase in the oxygen depletion rate in the central basin hypolimnion, and a resultant increase in the areal extent of anoxic waters. These changes, documented by Herdendorf, are shown in Table 2-356. Sediment cores show increasing concentrations of metal (Hg, Cr, Ni) near the surface which are probably related to increased deposition rates (2-187), but may in some cases result from post-depositional mobility in the sediments. DDT and PCB concentrations are generally too low to be observed in lake water, but concentrations of DDT in fish have decreased in recent years while PCBs in fish tissue have remained constant. Mercury concentrations in Lake Erie fish have stabilized since 1970. (2-188) Most recent evidence indicates that phosphate inputs to the Great Lakes have nearly stabilized while ammonia and total nitrogen inputs continue to increase. (2-179)

Quality of Inland Waters Within the Regional Study Area

Water Quality in the Major River Basins

2.643
Grand River Basin. Although the lower portion of the Grand River (which is outside of the Regional Study Area) continues to be adversely affected by industrial wastes, the upper reaches of this river basin are considered to have relatively high water quality. (2-164,163) A water quality survey of several stations on the upper Grand and its tributaries was conducted by the USEPA Region V on 9 April 1973. (2-163) Aside from exceeding recreational-use bacteria standards, all stations exhibited complete compliance with State water quality standards. One station, downstream of Rock Creek's water supply intake from the Grand River, indicated the water at that point met public water supply criteria during that survey. A subsequent survey (25 June 1973) found high mercury concentrations in the main stream, with the high value of 1.7 ug/l near Madison, Ohio, just to the west of the Ashtabula County line. The State standard

Table 2-356

Trends of Oxygen Depletion Rate and Area of Anoxic Waters in the Central Basin Hypolimnion -- 1930-1974

Year	Anoxic Area (km^2)	Depletion Rate Per Unit Area (mg O^2 cm^{-2} day^{-1})
1930	300	0.008
1940		0.015
1950		0.025
1959	3,600	
1960	1,660	0.039
1961	3,640	
1964	5,870	
1967	7,500	
1970	6,600	0.039
1972	7,970	
1973	11,270	0.053
1974	10,250	0.047

Source: Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River, Vol. 2--Lake Erie. International Lake Erie Pollution Board, 1969, and "Lake Erie Nutrient Control Assessment," C.E. Herdendorf, Center for Lake Erie Area Research. A report to the U.S. Environmental Protection Agency (in press).

for mercury is 0.5 ug/l (maximum allowable concentration). Additional surveys were conducted at various stations on 30 July 1973 and 5 September 1973; again substantial compliance with the State standards was evident. Possible violations of recreational criteria were found, a high concentration of cadmium (22 ug/l) was recorded in Mill Creek, mercury was detected at concentrations near or just below the State standard, and dissolved oxygen was measured at 4.0 mg/l on Mill Creek (below the Jefferson sewage treatment plant discharge). (2-163) The data from a one-time sample analysis of the Grand River during the April high-flow period is shown in Table 2-357. Flow in the river at the USGS gauge near Madison, Ohio, on the sampling date was 36.5 m^3/sec, slightly above the April mean monthly flow of 32.8 m^3/sec, while the flow at the sampling location for the data given is only slightly lower.

2.644
Ashtabula River Basin. The Ashtabula River basin as a whole is considered to have high water quality (2-164) though the lower river is significantly polluted as a result of point source discharges. (2-161) These problems have included high concentrations of total dissolved solids, chlorides, ammonia, phenols and coliform bacteria, and low levels of dissolved oxygen. (2-161) The USEPA conducted several water quality surveys in the basin in 1973. (2-163) A survey in the high runoff period (April) showed the lower part of the river to have the following problems: High cadmium concentrations of 19 ug/ and 14 ug/ versus a State water quality standard of 5 ug/ ; Significant amounts of mercury, up to 0.5 ug/ ; Temperatures in Fields Brook of 12.0°C, versus a natural temperature of 4.0°C (water quality standard exceeded); Strong odor of chlorine.

2.645
Dry weather samples were collected in June, July and August by the EPA. (2-163) Problems noted in the lower part of the river (including Fields Brook) from the sample data included: Low dissolved oxygen, down to 3.4 mg/l at the river bottom versus a standard of 5 mg/l ; High bacterial counts; High ammonia concentrations; High mercury concentrations, up to 0.5 ug/l; High lead concentrations, up to 40 ug/l which is the State water quality standard; Violations of temperature standards, with temperatures up to 30°C in Fields Brook; The presence of algae; A high barium concentration for one sample, 600 ug/l versus a water quality standard of 800 ug/l; and Evidence of untreated or partially treated sewage. The EPA's data show the water quality in the upper Ashtabula River and tributaries) to be fairly good with the only problems relating to high bacteria counts, relatively high mercury concentrations, and one low dissolved oxygen value. The State of Ohio also monitors the Ashtabula River at Ashtabula near the mouth. Their data, covering the period from October 1975 to September 1976, are given in Table 2-358.

Table 2-357

Example of Water Quality Data in the Grand River(1)

Parameter, Units	Value	Parameter	Value (µg/ℓ)
pH, units	7.2	Aluminum (total)	712.0
Temperature, °C	9.50	Arsenic (total)	<10.0
Conductivity, µmhos/om	185.0	Barium (total)	<360.0
Dissolved oxygen, mg/ℓ	10.2	Cadmium (total)	<8.0
BOD_5, mg/ℓ	2.0	Chromium (total)	<20.0
BOD_{20}, mg/ℓ	5.0	Copper (total)	<15.0
COD, mg/ℓ	22.0	Iron (total)	1,020.0
Total Solids, mg/ℓ	131.0	Lead (total)	<50.0
Dissolved Solids, mg/ℓ	126.0	Manganese (total)	82.0
Suspended Solids, mg/ℓ	16.0	Mercury (total)	0.3
Hardness, mg/ℓ $CaCO_3$	73.0	Nickel (total)	<30.0
Alkalinity, mg/ℓ $CaCO_3$	33.0	Silver (total)	<40.0
Acidity, mg/ℓ $CaCO_3$	3.0	Zinc (total)	<40.0
Chloride, mg/ℓ	15.0		
Fluoride, mg/ℓ	0.09		
Sulfate, mg/ℓ	37.0		
Phosphorus (total), mg/ℓ	0.049		
Total Kjelkahl-N, mg/ℓ	0.51		
Ammonia-N, mg/ℓ	0.04		
Nitrate-Nitrite-N, mg/ℓ	0.20		
Oil and Grease, mg/ℓ	0.06		
Cyanide, total, mg/ℓ	<0.005		
Phenol, mg/ℓ	<0.002		
Total coliform, #/100 mℓ	1,200.0		
Fecal coliform, #/100 mℓ	290.0		
Fecal strep., #/100 mℓ			

(1) Grand River near Austinburg, Ohio; River Mile 40.6, April 9, 1973.

Source: "Northeast Ohio Tributaries to Lake Erie, Waste Load Allocation Report," USEPA Region V, March 1974.

Table 2-358

Water Quality in the Ashtabula River at Ashtabula, Ohio on 5th ST (October 1975 to September 1976)

Parameter	Unit	WQS(1)	N(2)	Maximum	Minimum	Average	V(3)
Flow	cfs	-	-	--	--	--	
Temperature	°C	*	8	20.0	3.5	11.2	
pH	S.U.	6.0-9.0	8	7.9	6.7	7.5	
NH-3-N	mg/l	-	8	0.38	0.13	0.20	
TKN-N	mg/l	-	8	0.7	0.3	0.5	
Nitrate	mg/l	-	8	0.65	0.20	0.37	
Total Phosphorous	mg/l	-	8	0.10	0.05	0.09	
BOD_5	mg/l	-	6	3.6	1.5	2.3	
DO	% Saturation		8	80.4	29.0	62.7	
DO	mg/l	5.0	8	10.2	3.8	7.0	1
Dissolved Solids	mg/l	1,500.0	6	472.0	103.0	320.0	
Suspended Solids	mg/l	-	6	21.0	10.0	13.0	
TOC	mg/l	-	8	15.0	1.0	8.0	
Oil-Grease	mg/l	5.0	2	5.0	5.0	--	
Fecal Coliform(4)	#/100 ml	200.0	4	9,300.0	230.0	1,021.0	4
Fecal Strep.(4)	#/100 ml	-	6	3,000.0	39.0	396.0	
MBAS	mg/l	0.5	8	0.17	0.07	0.12	
Conductivity	Micromhos	-	6	800.0	190.0	480.0	
Turbidity	J.U.	-	7	14.0	3.30	7.04	
Total Hardness	mg/l	-	5	314.0	116.0	194.0	
Phenols	ug/l	10.0	7	6.0	2.0	--	
Cyanide	mg/l	0.2	8	0.01	0.01	--	
Chloride	mg/l	250.0	8	280.0	56.0	121.6	1
Fluoride	mg/l	1.3	3	0.17	0.13	0.15	
Arsenic	ug/l	50.0	2	10.0	10.0	--	
Barium	ug/l	800.0	2	200.0	200.0	--	
Cadmium	ug/l	5.0	2	10.0	5.0	--	
Total Chromium	ug/l	300.0	2	30.0	30.00	--	
Copper	ug/l	*	4	30.0	30.0	--	
Total Iron	ug/l	-	4	1,310.0	520.0	830.0	
Lead	ug/l	40.0	3	10.0	10.0	--	
Manganese	ug/l	-	3	160.0	90.0	137.0	
Mercury	ug/l	0.5	3	0.5	0.5	--	
Selenium	ug/l	5.0	2	10.0	10.0	--	
Silver	ug/l	1.0	2	30.0	30.0	--	
Zinc	ug/l	*	5	90.0	30.0	--	
Aluminum	ug/l	-	--	--	--	--	
Sulfate	mg/l	-	4	94.0	49.0	69.2	
Hex. Chromium	ug/l	50.0	2	30.0	30.0	--	

(1) Water Quality Standards.
(2) Number of samples taken.
(3) Number of samples in violation.
(4) Fecal coliform and strep are geometric means. All others are arithmetic.

* Variable - refer to Water Quality Standards

Source: Ohio Environmental Protection Agency.

2.646
Conneaut Creek Basin. The State of Ohio considers their portion of Conneaut Creek to be a high water quality area. The lower portion of the river at Conneaut is affected by point source discharges, and data from the OEPA, shown in Table 2-359, indicates that Ohio standards have been violated for pH, fecal coliforms, methylene blue active substances, phenols, and lead. The USEPA Region V sampled the Ohio portion of the creek in 1973 (three stations on two different dates) and noted the following problems: High cadmium concentrations, up to 13 ug/l versus a water quality standard of 5 ug/l; Relatively high mercury concentrations, up to 0.6 ug/l; and a violation of the dissolved oxygen standard at the mouth of the creek in August, with values down to 2.8 mg/l at river bottom. The EPA's data for their station near the Ohio-Pennsylvania State line (river mile 23.4) are given in Table 2-360.

2.647
French Creek Basin. Although French Creek has not always met Pennsylvania water quality standards in recent sampling programs (2-189), the whole northwestern portion of Pennsylvania, a large portion of which is drained by the French Creek basin, is considered to have good water quality. Of the 567 miles of major streams in this area, 99 percent are estimated to meet or better all water quality criteria except those for bacteria. (2-190) Recent data on the water quality in French Creek in Union Township is presented in Table 2-361. These data indicate standards exceedance at this station for iron (standard is 1.5 mg/l for total iron) and fecal coliforms (standard is 200/100m for mean of sample analyses).

Water Quality in the Smaller Streams of the Study Area

2.648
Ohio Streams. The USEPA Region V sampled Cowles Creek (two stations), Red Brook (two stations) and Turkey Creek (one station) at different times in 1973. (2-163) Problems in Cowles Creek included: High values of cadmium, up to 13 ug/l versus the standard of 5 ug/l; Relatively high values of mercury, up to 1.7 ug/l in one sample; and adverse effects of point source discharges including high ammonia values (up to 2.8 mg/l versus a standard of 1.5 mg/l), bacterial contamination, and a violation of the dissolved oxygen standard (3.3 mg/l low value). Red Brook also showed adverse impacts from point source discharges with: Violations of the dissolved oxygen standard (3.5 mg/l, low value); Slight exceedence of the temperature standard; High bacterial counts; and exceedence of mercury standards. In Turkey Creek, which has no known point source discharges, the cadmium standard was exceeded in one sample, and the fecal coliform standard was exceeded in both samples. Mercury concentrations were relatively

Table 2-359

Water Quality in Conneaut Creek at Conneaut, Ohio (October 1975 to September 1976)

Parameter	Unit	WQS (1)	N (2)	Maximum	Minimum	Average	V (3)
Flow	cfs	-	6	1,092.0	14.0	239.0	
Temperature	°C	*	9	17.0	0.2	7.4	
pH	S.U.	6.0-9.0	8	9.3	7.4	7.8	1
NH-3-N	mg/l	-	9	0.32	0.05	0.18	
TKN-N	mg/l	-	8	1.1	0.3	0.4	
Nitrate	mg/l	-	9	0.79	0.04	0.35	
Total Phosphorous	mg/l	-	9	0.10	0.05	0.09	
BOD_5	mg/l	-	8	4.0	1.0	1.7	
DO	% Saturation		9	98.0	69.1	80.8	
DO	mg/l	5.0	9	11.2	6.7	9.9	
Dissolved Solids	mg/l	1,500.0	10	1,340.0	89.0	262.0	
Suspended Solids	mg/l	-	8	89.0	10.0	36.0	
TOC	mg/l	-	9	15.0	1.0	5.6	
Oil-Grease	mg/l	5.0	3	5.0	1.0	--	
Fecal Coliform (4)	#/100 ml	200.0	9	900.0	18.0	75.0	3
Fecal Strep. (4)	#/100 ml	-	9	2,900.0	9.0	70.0	
MBAS	mg/l	0.5	8	0.59	0.50	0.13	1
Conductivity	Micromhos	-	8	1,400.0	100.0	345.0	
Turbidity	J.U.	-	6	32.00	2.00	13.33	
Total Hardness	mg/l	-	6	270.0	86.0	139.0	
Phenols	ug/l	10.0	7	17.0	2.0	--	1
Cyanide	mg/l	0.2	7	0.03	0.01	--	
Chloride	mg/l	250.0	8	19.0	11.0	15.4	
Fluoride	mg/l	1.3	5	0.23	0.09	0.13	
Arsenic	ug/l	50.0	3	10.0	10.0	--	
Barium	ug/l	800.0	3	300.0	200.0	--	
Cadmium	ug/l	5.0	3	10.0	5.0	--	
Total Chromium	ug/l	300.0	4	30.0	30.0	--	
Copper	ug/l	*	4	40.0	30.0	--	
Total Iron	ug/l	-	3	3,600.0	810.0	2,570.0	
Lead	ug/l	40.0	4	100.0	16.0	44.0	1
Manganese	ug/l	-	4	1,120.0	40.0	328.0	
Mercury	ug/l	0.5	2	0.5	0.5	--	
Selenium	ug/l	5.0	4	10.0	5.0	--	
Silver	ug/l	1.0	2	30.0	30.0	--	
Zinc	ug/l	*	4	120.0	30.0	--	
Aluminum	ug/l	-	2	1,900.0	200.0	--	
Sulfate	mg/l	-	6	153.0	32.0	61.7	
Hex. Chromium	ug/l	50.0	4	30.0	30.0	--	

(1) Water Quality Standards.
(2) Number of samples taken.
(3) Number of samples in violation.
(4) Fecal coliform and strep are geometric means. All others are arithmetic.

* Variable - refer to Water Quality Standard.

Source: Ohio Environmental Protection Agency.

Table 2-369

Examples of Water Quality Data for Upstream Point on Conneaut Creek[1]

Parameter, Units	Value 4/73	Value 8/73	Parameter	Value 4/73 (μg/ℓ)	Value 8/73 (μg/ℓ)
pH, units	7.2	-	Aluminum (total)	<700	<700
Temperature, °C	7.2	22.8	Arsenic (total)	<10	<10
Conductivity, μmhos/om	160.0	-	Barium (total)	<360	<400
Dissolved oxygen, mg/ℓ	13.0	8.0	Cadmium (total)	13	<8
BOD_5, mg/ℓ	2.0	1.0	Chromium (total)	<20	<20
BOD_{20}, mg/ℓ	3.0	3.0	Chromium (hexavalent)	-	<5
COD, mg/ℓ	13.0	22.0	Copper (total)	18	35
Total Solids, mg/ℓ	146.0	269.0	Iron (total)	596	684
Dissolved solids, mg/ℓ	136.0	231.0	Lead (total)	<50	<50
Suspended solids, mg/ℓ	18.0	11.0	Manganese (total)	32	51
Hardness, mg/ℓ $CaCO_3$	69.0	147.0	Mercury (total)	0.5	0.3
Acidity, mg/ℓ $CaCO_3$	5.0	4.0	Nickel (total)	<30	<50
Chloride, mg/ℓ	9.0	23.0	Selenium (total)	<3	<10
Fluoride, mg/ℓ	0.07	0.1	Silver (total)	<40	<40
Sulfate, mg/ℓ	30.0	42.0	Tin (total)	-	<600
Total Phosphorus, mg/ℓ	0.082	0.042	Zinc (total)	<40	54
Total kjeldahl-N, mg/ℓ	0.25	0.58			
Ammonia-N, mg/ℓ	0.03	0.16			
Nitrate-Nitrite-N, mg/ℓ	0.25	0.06			
Oil and Grease, mg/ℓ	0.7	0.5			
Cyanide, total	<0.01	<0.005			
Phenol, mg/ℓ	<0.002	<0.002			
Total coliform, #/100 mℓ	240.0	3,000.0			
Fecal coliform, #/100 mℓ	180.0	20.0			
Fecal strep, #/100 mℓ	480.0	20.0			

(1) River Mile 23.4, near Ohio-Pennsylvania state line.

Source: "Northeast Ohio Tributaries to Lake Erie, Waste Load Allocation Report," U.S. Environmental Protection Agency Region V, March 1974.

Table 2-361

Water Quality Data for French Creek, Union Township, Pennsylvania(1)

Parameter, Units	Mean	Maximum	Minimum
Temperature, °C	14.4	26.0	1.0
Turbidity, JTU	10.2	60.0	0.2
Conductivity, μmho/cm	224.0	395.0	130.0
Dissolved oxygen, mg/ℓ	9.06	12.0	6.0
pH, units	7.6	7.8	7.5
Total Alkalinity, mg/ℓ	70.0	119.0	20.0
Total residue, mg/ℓ	281.0	376.0	144.0
Dissolved Residue, mg/ℓ	162.0	296.0	11.0
Total NFLT Residue, mg/ℓ	45.0	212.0	2.0
Settleable Residue, mg/ℓ	0.375	0.9	0.2
Ammonia-N	0.22	0.58	0.029
NO_2-N, mg/ℓ	0.035	0.64	0.002
NO_3-N, mg/ℓ	0.60	2.6	0.03
Total phosphorus, mg/ℓ	0.106	0.43	0.02
Hardness, mg/ℓ	96.6	166.0	36.0
Calcium (dissolved), mg/ℓ	26.0	33.7	11.2
Calcium (total), mg/ℓ	27.8	59.3	1.9
Magnesium (dissolved), mg/ℓ	6.7	10.2	2.0
Magnesium (total), mg/ℓ	6.6	12.2	3.4
Chloride, mg/ℓ	13.7	25.0	5.0
Sulfate, mg/ℓ	29.5	126.0	3.0
Fecal Coliforms, #/100 mℓ	260.0	900.0	10.0
Cadmium (total), μg/ℓ	3.0	3.0	3.0
Chromium (total), μg/ℓ	16.7	20.0	10.0
Copper (total), μg/ℓ	16.7	20.0	10.0
Iron (total), μg/ℓ	1,024.0	4,870.0	240.0
Lead (total), μg/ℓ	50.0	50.0	50.0
Manganese (total), μg/ℓ	110.0	180.0	70.0
Nickel (total), μg/ℓ	37.0	70.0	20.0
Zinc (total), μg/ℓ	20.0	30.0	10.0
Aluminum (total), μg/ℓ	440.0	500.0	320.0
Mercury (total), μg/ℓ	2.0	2.0	2.0

(1) Data are from various sampling dates between 1973 and 1976. Location is Lat. 41° 35' 21.0", Long. 80° 9' 1".

Source: STORET data, based on information submitted by Pennsylvania Department of Environmental Resources.

high (0.4 ug/l). The EPA data for these streams are given in Tables 2-362 and 2-363. The station locations are described in Table 2-364.

2.649
Pennsylvania Streams. There are numerous small streams in the Regional Study Area. Table 2-365 indicates the relationship between the water quality in several creeks and the State water quality criteria. Of the 18 streams listed only Crooked Creek, Little Elk Creek, Twelvemile Creek, and Twentymile Creek have met or bettered the water quality criteria for all available observations. (2-161,162) The Pennsylvania Water Quality Inventory (1976) indicates additional problems for Elk Creek. (2-190) The report states that 1.5 miles of the stream are degraded by high ammonia-nitrogen concentrations and localized dissolved oxygen problems due to the discharge of raw sewage. The stream is expected to meet water quality standards by 1983 according to this report. Water quality data in Elk Creek are given in Table 2-366; it is from the Pennsylvania DER monitoring station on the creek just north of Route 5.

Water Quality in the Inland Lakes

2.650
Relatively little data are available on the water quality in the inland lakes and reservoirs. The comments quoted below are for three lakes in the Pennsylvania part of the Regional Study Area, but they are probably typical for other lakes in the area as well. The Pennsylvania Department of Environmental Resources has stated the following:

> "Lakes Edinboro, Le Boeuf, and Pleasant are presently changing their character towards a marsh-type environment through a process called eutrophication. Lake Edinboro, only one-half as deep as it was two decades ago, has high concentrations of nitrates and phosphates in the lower water layers, and has a history of algae blooms and massive weed growth reaching the surface. The sediments in Lake Edinboro were also found to be polluted. Le Boeuf Lake was assessed to be in the same lake succession state as Lake Edinboro, i.e., the lake is rapidly progressing towards a wetlands-type condition. Lake Pleasant is presently at an earlier, less eutrophic, state, but the lake is highly responsive to pollution by discharges in the drainage basin because of a low flushing rate (residence time of 280 days)."

> "Total coliform concentrations in these lakes have increased recently. The average concentrations during the summer periods 1970 to 1972 have increased from 204 to 1,727 MPN/100 ml for Edinboro Lake, from 133 to 964 MPN/100 ml for Lake Pleasant and

Table 2-362

Water Quality at Cowles Creek

Survey Date:		April 10, 1973		June 25, 1973		August 14, 1973	
Station Number		1	2	1	2	1	2
River Mile		0.2	6.9	0.2	6.9	0.2	6.9
Modo Sample Number		3,421.0	3,422.0	3,743.0	3,744.0	8,174.0	8,175.0
Flow	(cfs)						
pH	(STD units)	7.2	7.2	7.2	7.0	7.1	6.8
Temperature	(°F)	44.6	41.0	75.2	69.8	67.1	66.2
Conductivity	(µmhos/cm)	320.0	225.0	620.0	330.0	700.0	560.0
Dissolved Oxygen	(mg/ℓ)	11.4	12.0	7.8	7.3	6.4	3.3
BOD_5	(mg/ℓ)	4.0	2.0	7.0	2.0	6.0	2.0
BOD_{20}	(mg/ℓ)	8.0	5.0	16.0	5.0	18.0	5.0
COD	(mg/ℓ)	23.0	19.0			46.0	40.0
TOC	(mg/ℓ)						
Solids, Total	(mg/ℓ)	261.0	191.0	451.0	270.0	624.0	444.0
Solids, Dissolved	(mg/ℓ)	247.0	183.0	436.0	255.0	592.0	368.0
Solids, Suspended	(mg/ℓ)	31.0	22.0	7.0	14.0	5.0	26.0
Hardness	(mg/ℓ $CaCO_3$)	111.0	92.0	91.0	156.0	192.0	190.0
Alkalinity	(mg/ℓ $CaCO_3$)	52.0	43.0	148.0	118.0	202.0	127.0
Acidity	(mg/ℓ $CaCO_3$)	8.0	7.0	4.0	4.0	<4.0	<4.0
Chloride	(mg/ℓ)	32.0	18.0	67.0	24.0	90.0	35.0
Fluoride	(mg/ℓ)	0.09	0.07	0.4	0.1	0.7	
Sulfate	(mg/ℓ)	61.0	46.0	100.0	43.0	145.0	34.0
Phosphorus, Total	(mg/ℓ, P)	0.209	0.033	1.19	0.058	2.85	0.076
Total Kjeldahl-N	(mg/ℓ)	0.97	0.43			4.70	1.90
Ammonia-N	(mg/ℓ)	0.25	0.04			2.82	0.19
Nitrate-Nitrite-N	(mg/ℓ)	1.5	0.15	1.19	0.69	2.79	0.13
Oil and Grease	(mg/ℓ)	<0.5	<0.5			<0.5	<0.5
Cyanide, Total	(mg/ℓ)	<0.01	<0.01			<0.005	<0.005
Phenol	(mg/ℓ)	<0.002	<0.002			<0.002	<0.002
Total Coliform	(#/100 mℓ)	780.0	640.0	8,000.0	5,500.0	4,800.0	3,500.0
Fecal Coliform	*(#/100 mℓ)*	76.0	90.0	2,000.0	540.0	600.0	1,500.0
Fecal Strep.	(#/100 mℓ)	150.0	270.0	3,000.0	2,400.0	720.0	1,200.0
Aluminum, Total	(µg/ℓ)	<700.0	812.0	<700.0	<700.0	<700.0	<700.0
Arsenic, Total	(µg/ℓ)	<10.0	<10.0			<10.0	<10.0
Barium, Total	(µg/ℓ)	<360.0	<360.0	<360.0	<360.0	600.0	<400.0
Cadmium, Total	(µg/ℓ)	13.0	13.0	<8.0	<8.0	<8.0	<8.0
Chromium, Total	(µg/ℓ)	27.0	<20.0	<20.0	<20.0	<20.0	<20.0
Chromium, Hexavalent	(µg/ℓ)			<5.0	<5.0	<5.0	<5.0
Copper, Total	(µg/ℓ)	42.0	<15.0	97.0	99.0	66.0	43.0
Iron, Total	(µg/ℓ)	1,670.0	980.0	844.0	1,534.0	929.0	1,200.0
Lead, Total	(µg/ℓ)	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
Manganese, Total	(µg/ℓ)	80.0	38.0	129.0	180.0	142.0	603.0
Mercury, Total	(µg/ℓ)	0.4	0.2	1.3	0.7	0.4	0.3
Nickel, Total	(µg/ℓ)	61.0	30.0	95.0	77.0	<50.0	<50.0
Selenium, Total	(µg/ℓ)	<3.0				10.0	10.0
Silver, Total	(µg/ℓ)	<40.0	<40.0	<40.0	<40.0	<40.0	<40.0
Tin, Total	(µg/ℓ)					<600.0	
Zinc, Total	(µg/ℓ)	64.0	40.0	123.0	61.0	144.0	52.0

Source: "Northeast Ohio Tributaries to Lake Erie, Waste Load Allocation Report," U.S. Environmental Protection Agency, Region V, March 1974.

Table 2-363

Water Quality in Red Brook and Turkey Creek

Survey Date:		Red Bk. June 25, 1973		Red Bk. August 14, 1973		Turkey Cr. April 10	Turkey Cr. August 14
Station Number		3	4	3	4	5	5
River Mile		0.3	2.0	0.3	2.0	0.1	0.1
Modo Sample Number		3,745.0	3,746.0	8,171.0	8,172.0	3,420.0	8,173.0
Flow	(cfs)						
pH	(STD units)	7.0	7.3	6.7	7.0	7.2	
Temperature	(°F)	77.0	71.6	72.5	66.2	42.8	66.2
Conductivity	(µmhos/cm)	460.0	440.0	625.0	525.0	290.0	
Dissolved Oxygen	(mg/ℓ)	4.6	8.9	3.5	7.5	11.7	
BOD_5	(mg/ℓ)	3.0	2.0	2.0	2.0	1.0	0
BOD_{20}	(mg/ℓ)	10.0	5.0	6.0	5.0	3.0	2.0
COD	(mg/ℓ)			28.0	35.0	17.0	29.0
TOC	(mg/ℓ)						
Solids, Total	(mg/ℓ)	372.0	352.0	476.0	405.0	213.0	421.0
Solids, Dissolved	(mg/ℓ)	338.0	317.0	427.0	362.0	213.0	375.0
Solids, Suspended	(mg/ℓ)	22.0	15.0	14.0	15.0	18.0	7.0
Hardness	(mg/ℓ $CaCO_3$)	167.0	169.0	223.0	184.0	97.0	154.0
Alkalinity	(mg/ℓ $CaCO_3$)	133.0	132.0	99.0	110.0	38.0	91.0
Acidity	(mg/ℓ $CaCO_3$)	3.0	2.0	<4.0	<4.0	7.0	<4.0
Chloride	(mg/ℓ)			51.0	49.0	37.0	97.0
Fluoride	(mg/ℓ)			0.3	0.6	0.07	0.1
Sulfate	(mg/ℓ)			140.0	80.0	49.0	55.0
Phosphorus, Total	(mg/ℓ, P)	0.393	0.339	0.394	0.360	0.161	0.019
Total Kjeldahl-N	(mg/ℓ)			0.80	1.90	0.49	1.80
Ammonia-N	(mg/ℓ)			0.48	0.24	0.03	0.04
Nitrate-Nitrite-N	(mg/ℓ)	1.00	0.59	0.44	4.20	0.30	0.20
Oil and Grease	(mg/ℓ)	<0.5	<0.5	<0.5	0.5	<0.5	<0.5
Cyanide, Total	(mg/ℓ)	<0.01	<0.01	<0.005	<0.005	<0.01	<0.005
Phenol	(mg/ℓ)	0.004	0.003	<0.002	<0.002	<0.002	<0.002
Total Coliform	(#/100 mℓ)	89,000.0	38,000.0	5,800.0	9,000.0	760.0	2,600.0
Fecal Coliform	(#/100 mℓ)	12,000.0	13,000.0	400.0	1,000.0	260.0	420.0
Fecal Strep.	(#/100 mℓ)	780.0	460.0	150.0	600.0	130.0	180.0
Aluminum, Total	(µg/ℓ)	<700.0	<700.0	<700.0	700.0	<700.0	<700.0
Arsenic, Total	(µg/ℓ)			<10.0	<10.0	<10.0	<10.0
Barium, Total	(µg/ℓ)	<360.0	<360.0	<400.0	<400.0	<360.0	<400.0
Cadmium, Total	(µg/ℓ)	<8.0	<8.0	<8.0	<8.0	10.0	<8.0
Chromium, Total	(µg/ℓ)	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Chromium, Hexavalent	(µg/ℓ)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Copper, Total	(µg/ℓ)	87.0	72.0	26.0	48.0	22.0	<20.0
Iron, Total	(µg/ℓ)	1,628.0	1,336.0	1,270.0	842.0	704.0	676.0
Lead, Total	(µg/ℓ)	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
Manganese, Total	(µg/ℓ)	220.0	206.0	371.0	180.0	59.0	162.0
Mercury, Total	(µg/ℓ)	0.8	1.1	0.2	0.3	0.4	0.4
Nickel, Total	(µg/ℓ)	64.0	63.0	<50.0	<50.0	<30.0	<50.0
Selenium, Total	(µg/ℓ)					<3.0	
Silver, Total	(µg/ℓ)	<40.0	<40.0	<40.0	<40.0	<40.0	<40.0
Tin, Total	(µg/ℓ)			<600.0	<600.0		
Zinc, Total	(µg/ℓ)	69.0	44.0	71.0	56.0	<40.0	<50.0

Source: "Northeast Ohio Tributaries to Lake Erie, Waste Load Allocation Report," U.S. Environmental Protection Agency, Region V, March 1974.

Table 2-364

1973 Water Quality Surveys of Minor Tributaries to Lake Erie

Station Number	Station Name	Station Description	Station Location: River Mile	Latitude (°)	Latitude (')	Latitude (")		Longitude (°)	Longitude (')	Longitude (")	
1	Cowles Creek near Geneva-on-the-Lake	Ohio Route 534 Bridge	0.9	41	51	01	N	80	57	44	W
2	Cowles Creek above Geneva	Barnum Road Bridge	6.9	41	47	52	N	80	55	24	W
3	Mouth of Red Brook	Lake Road Bridge	0.2	41	53	02	N	80	51	03	W
4	Red Brook near Ashtabula	Wade Avenue Bridge	2.0	41	52	26	N	80	50	25	W
5	Turkey Creek near Conneaut	At Lake Road	0.1	41	58	24	N	80	31	48	W

Source: "Northeast Ohio Tributaries to Lake Erie, Waste Load Allocation Report," U.S. Environmental Protection Agency, Region V, March 1974.

Table 2-365

Small Streams in Pennsylvania
Stream Water Quality Constituent Concentrations
Compared to Stream Water Quality Criteria

Stream	Values Observed Which Do not meet WQ Criteria pH	DO	Fe	TDS	Bacteria	NH_3-N	PO_4-P
Mill Creek		X			X	X	X
Four-Mile Creek	X						
Sixteen-Mile Creek	X				X		
Elk Creek					X		
Conneaut Creek					X		
Twelve-Mile Creek							
Crooked Creek							
Trout Run			X		X		
Six-Mile Creek					X		
Seven-Mile Creek							
Eight-Mile Creek					X		
Twenty-Mile Creek							
Hare Creek			X		X	X	
Brandy Run			X		X		
Big Conneautee					X	X	X
Walnut Creek					X	X	
Little Elk Creek							
Raccoon Creek					X		

Source: "Executive Summary of the Comprehensive Waste and Water Quality Management Study of the Pennsylvania Portion of the Erie Basin and the Remaining Basin of Erie County," Pennsylvania Department of Environmental Resources, February 1976.

Table 2-365

Small Streams in Pennsylvania
Stream Water Quality Constituent Concentrations
Compared to Stream Water Quality Criteria

Stream	Values Observed Which Do not meet WQ Criteria						
	pH	DO	Fe	TDS	Bacteria	NH_3-N	PO_4-P
Mill Creek		X			X	X	X
Four-Mile Creek	X						
Sixteen-Mile Creek	X				X		
Elk Creek					X		
Conneaut Creek					X		
Twelve-Mile Creek							
Crooked Creek							
Trout Run			X		X		
Six-Mile Creek					X		
Seven-Mile Creek							
Eight-Mile Creek					X		
Twenty-Mile Creek							
Hare Creek			X		X	X	
Brandy Run			X		X		
Big Conneautee					X	X	X
Walnut Creek					X	X	
Little Elk Creek							
Raccoon Creek					X		

Source: "Executive Summary of the Comprehensive Waste and Water Quality Management Study of the Pennsylvania Portion of the Erie Basin and the Remaining Basin of Erie County," Pennsylvania Department of Environmental Resources, February 1976.

Table 2-366

Water Quality Data for Elk Creek, Girard Township, Pennsylvania(1)

Parameter (units)	Mean	Maximum	Minimum
Temperature, °C	15.	25.5	0.0
Flow, m^3/sec	2.59	8.07	0.0
Turbidity, JTU	5.4	33.	0.3
Color, Pt-Co units	20.*	-	-
Conductivity, µmhos/cm	367.	500.	260.
Dissolved oxygen, mg/ℓ	10.0	14.0	6.0
BOD_5, mg/ℓ	2.	3.	1.
pH, units	8.0	9.0	7.0
Alkalinity, mg/ℓ $CaCO_3$	83.	133.	15.
Total Residue, mg/ℓ	287.	412.	128.
Dissolved Residue, mg/ℓ	288.	408.	176.
Total NFLT Residue, mg/ℓ	2.	2.	2.
Settleable Residue, mg/ℓ	0.2*	-	-
NH_3-N, mg/ℓ	0.40	2.1	0.04
NO_2^-, mg/ℓ	0.030	0.11	0.001
NO_3^-, mg/ℓ	0.67	2.4	0.04
Total phosphorus, mg/ℓ	0.28	0.99	0.02
Dissolved phosphorus, mg/ℓ	0.76*	-	-
Calcium, dissolved, mg/ℓ	147.	234.	72.
Calcium total, mg/ℓ	40.6	76.1	20.
Magnesium, dissolved, mg/ℓ	12.2	20.0	9.3
Magnesium, tital, mg/ℓ	9.9	18.0	3.4
Chloride, mg/ℓ	36.7	55.	21.
Sulfate, mg/ℓ	63.9	102.	30.
Arsenic (total), µg/ℓ	20.*	-	-
Cadmium (total), µg/ℓ	3.	3.	3.
Chromium (total), µg/ℓ	28.	50.	20.
Copper (total), µg/ℓ	20.	20.	20.
Iron (total), µg/ℓ	284.	900.	60.
Lead (total), µg/ℓ	50.	50.	50.
Manganese, µg/ℓ	75.	180.	30.
Nickel (total), µg/ℓ	22.5	25.	20.
Zinc (total), µg/ℓ	45.	140.	10.
Fecal Coliform, No./100mℓ	10.	10.	10.
Mercury (total), µg/ℓ	0.8	2.0	0.2

(1)Data are from various sampling dates between 1973 and 1976. Station is 250 yards downstream from bridge on SR 5.

*Only one measurement reported.

Source: STORET data.

from 4,155 to 4,396 MPN/100 ml for Lake Le Boeuf. Thus Edinboro and Le Boeuf have conditions that, on the average, are unsuitable for water contact sports."

The largest inland water body in the study area is the Pymatuning Reservoir. Water quality data for this reservoir are given in Table 2-367.

Water Quality of Streams On and Near the Proposed Project Site

2.651
Water quality sampling at several locations in Conneaut Creek, Turkey Creek, Raccoon Creek and some of their small tributary streams was initiated by Aquatic Ecology Associates in April 1977. This sampling program will continue into April 1978 in order to provide a full year's data on water quality in the streams (and portions of Lake Erie) on and near the proposed project site. The sampling stations are shown in Figure 2-126. Typical data for temperature and dissolved oxygen at six sampling stations (three each on Turkey and Conneaut Creeks) are shown in Figures 2-127 and 2-128. These data, plus similar data obtained by Aquatic Ecology Associates at other stream locations, indicate that a sufficient level of dissolved oxygen was generally maintained during the sampling period (April to August 1977). Only one sample, from Conneaut Creek station CC1, had a dissolved oxygen (DO) concentration below the (Ohio) State water quality standard (a minimum of 4 mg/l for any one sample). The severe drop in DO observed at this station in the early August sample may be due to influence from the discharge of the Conneaut sewage treatment plant which is near this station. The water chemistry at three of the sampling stations is shown in Table 2-368. Mean values and ranges covering three different observations are given. In addition to these data, analyses for other parameters indicated levels below detection limits on most, if not all, sampling dates. These data are shown in Table 2-369. The data in both tables indicate good water quality. However, occasional excursions of the water quality standards for phenols, zinc, total dissolved solids, and fecal coliforms are evident, as is the influence of sewage discharges (e.g., from fecal coliform counts) on stations CC1 and CC2 near the mouth of Conneaut Creek. The data from the upstream station on Conneaut Creek (CC3) appear to indicate higher water quality at this point than at several other sampling stations. Nitrates and phosphorus were at or above levels capable of stimulating algae growth at all stream stations on one or more sampling dates. The levels of the various chemical parameters tested have so far been well within the limits for the maintenance of aquatic life. Chemical constituents of the sediments of these creeks are in Table 2-370.

Table 2-367

Water Quality in Pymatuning Reservoir[1]

Parameter (units)	No. of Samples	Mean	Maximum	Minimum
Water Temperature, °C	10	17.8	24.7	11.5
Turbidity, % transmission	7%	83.3%	89.%	76.%
Transparency, secchi, cm	3	16.3	25.	9.5
Conductivity, µmhos/cm	6	143.	152.	135.
Dissolved oxygen, mg/ℓ	7	9.1	10.6	7.3
pH, units	10	8.0	8.4	7.2
Alkalinity, mg/ℓ $CaCO_3$	10	34.8	41.	31.
NH_3-N, mg/ℓ	10	0.063	0.08	0.04
Kjeldhal-N, mg/ℓ	10	0.93	1.3	0.6
NO_2 and NO_3, mg/ℓ	10	0.20	0.46	0.02
Total Phosphorus, mg/ℓ	10	0.047	0.076	0.024
Dissolved Phosphorus, mg/ℓ	10	0.0068	0.011	0.005
Chlorophyl a, µg/ℓ	3	28.4	43.1	7.7

[1] Data from 1973; sampled in April and October. Station located in Pennsylvania at Latitude 41°, 33 ft, 0 in. and Longitude 80°, 30 ft, 36 in.

Source: STORET data.

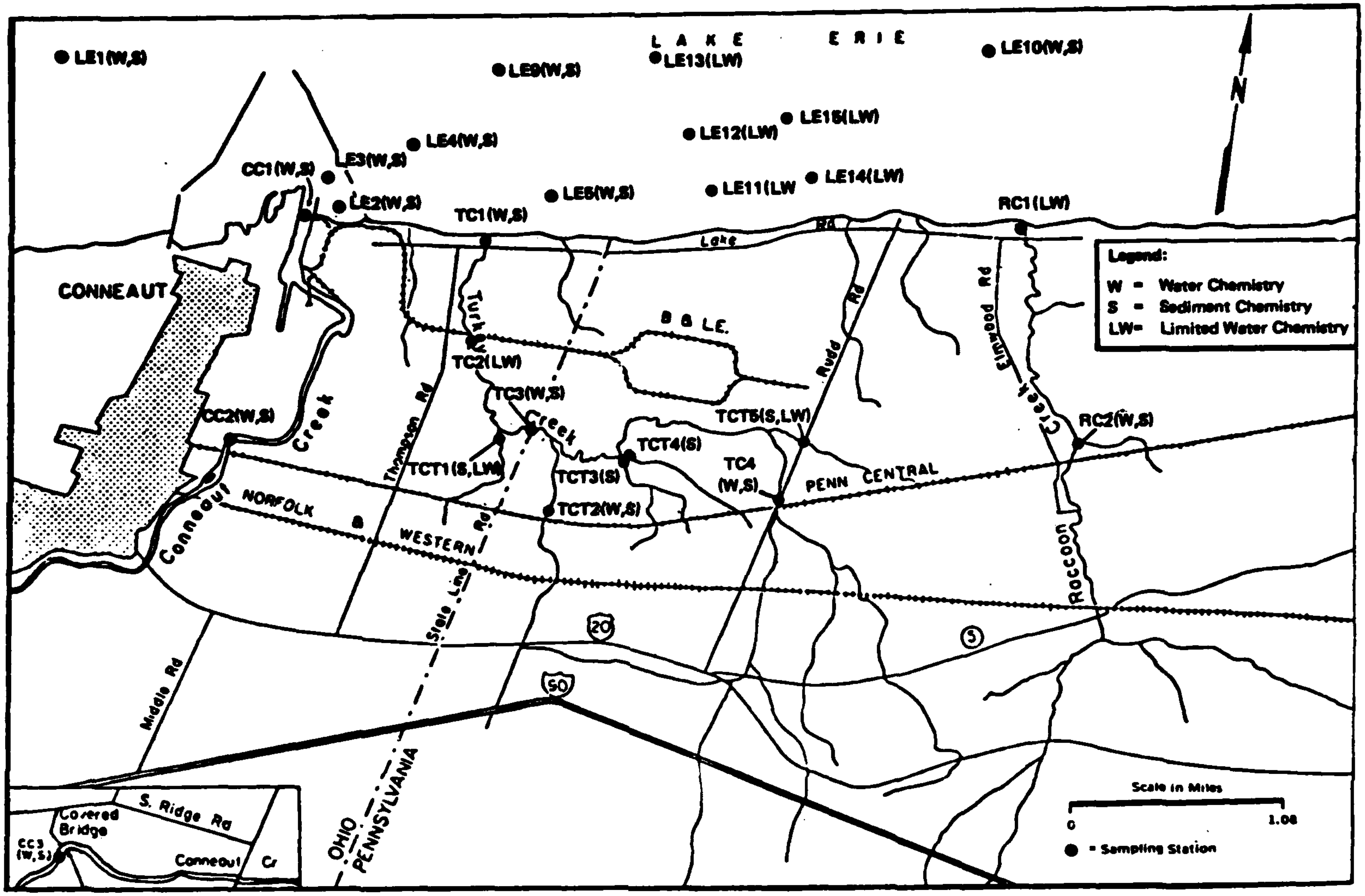
Table 2-368

Water Chemistry at Three Stream Stations -- April to August 1977
(All values expressed in mg/ℓ unless otherwise specified.)

Parameter	TC1 Turkey Creek Mean	TC1 Turkey Creek (Range)	RC2 Raccoon Creek Mean	RC2 Raccoon Creek (Range)	CC3 Conneaut Creek Mean	CC3 Conneaut Creek (Range)
Sp. Cond. (μmhos/cm)	460	(165-670)	430	(240-570)	240	(110-365)
pH (units)	7.7	(7.5-7.9)	7.8	(7.5-8.1)	7.8	(7.6-8.2)
Color (Pt-Co units)	55	(45-70)	38	(25-50)	38	(20-50)
Total Hardness	160	(134-194)	170	(150-198)	120	(96-150)
Cl	67	(36-108)	54	(41-67)	16	(9-21)
Sus. Solids	20	(9-36)	27	(22-31)	20	(9-28)
Diss. Solids	290	(222-392)	290	(251-349)	208	(124-279)
NO_2-N	0.01	(0.008-0.015)	0.009	(0.006-0.014)	0.006	(0.004-0.007)
NO_3-N	0.31	(0.04-0.56)	0.40	(0.30-0.56)	0.22	(0.04-0.48)
NH_3-N	0.15	(<0.02-0.23)	0.24	(0.20-0.26)	0.13	(<0.02-21)
PO_4-P	0.05	(0.02-0.10)	0.03	(0.02-0.04)	0.04	(0.01-0.055)
TKN	0.85	(0.44-1.1)	0.40	(0.21-0.74)	0.91	(0.26-1.9)
Fe (Total)	0.78	(0.65-1.0)	0.58	(0.29-0.83)	0.52	(0.25-1.0)
TOC	9.0	(7.4-12)	5.9	(2.5-8.8)	7.1	(4.3-11)
BOD_5	1.4	(<1-2.8)	1.3	(<1-2.4)	1.3	(<1-7.3)
Oil and Grease	2.7	(1.8-3.3)	2.8	(1.8-3.5)	1.8	(1.3-2.0)
Phenol	0.003	(0.001-0.005)	0.011	(0.004-0.021)	0.006	(<0.001-0.013)
Fecal Coliform (No./100mℓ)	8.	(<2-21)	58	(<2-150)	3	(<2-4)
Ca(1)	38		51		33	
Sus. Vol. Solids(1)	2		<1		1	
Soluble Reactive P(1)	0.007		0.009		0.011	
Zn	5.017	(<0.01-0.08)	0.01	(<0.01-0.02)	0.036	(<0.01-0.24)

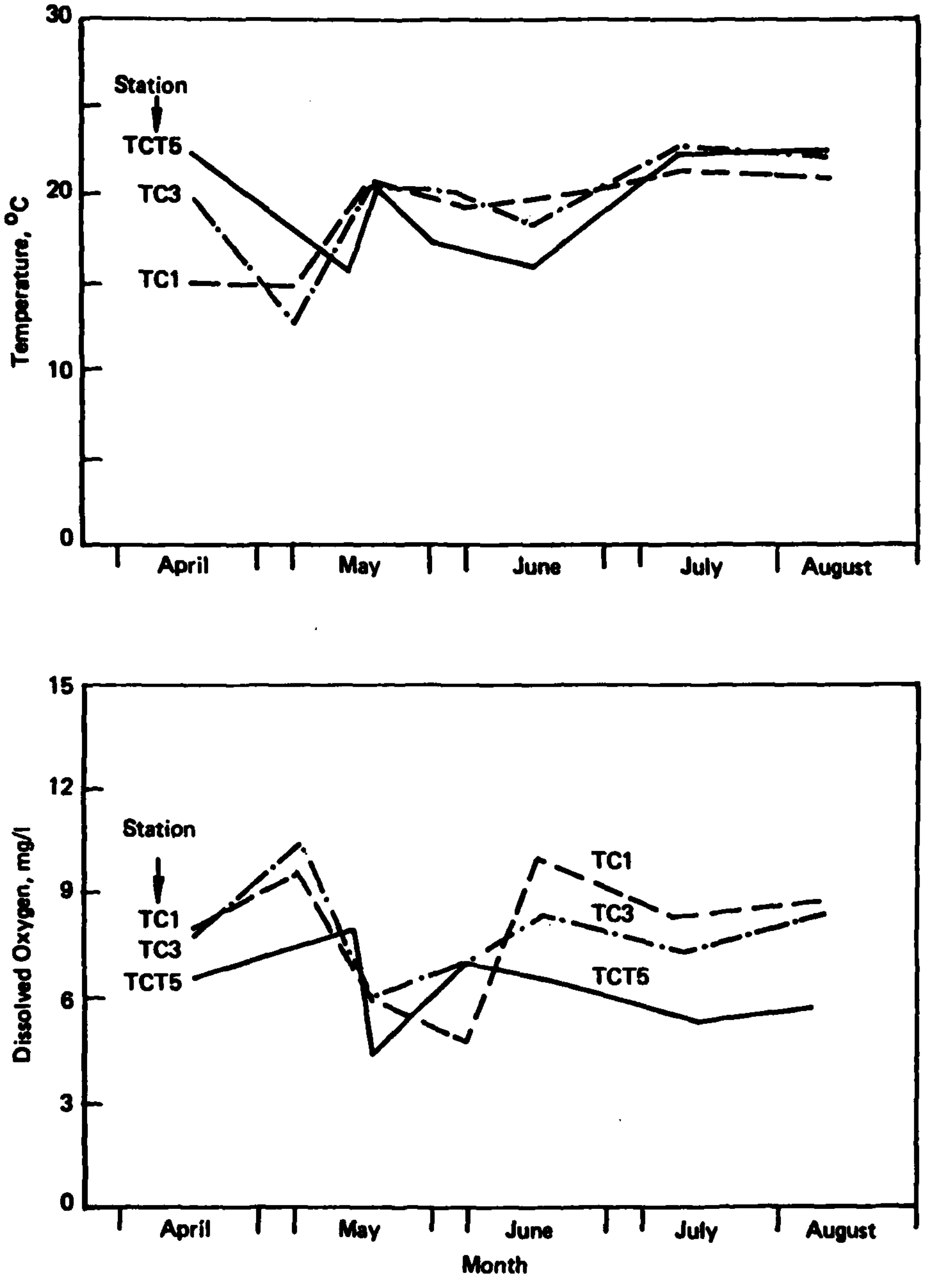
(1) Only one value (from August 17, 1977) available. For all other parameters three observations were available.

Source: Data from Aquatic Ecology Associates, Second Interim Report (Appendix E).



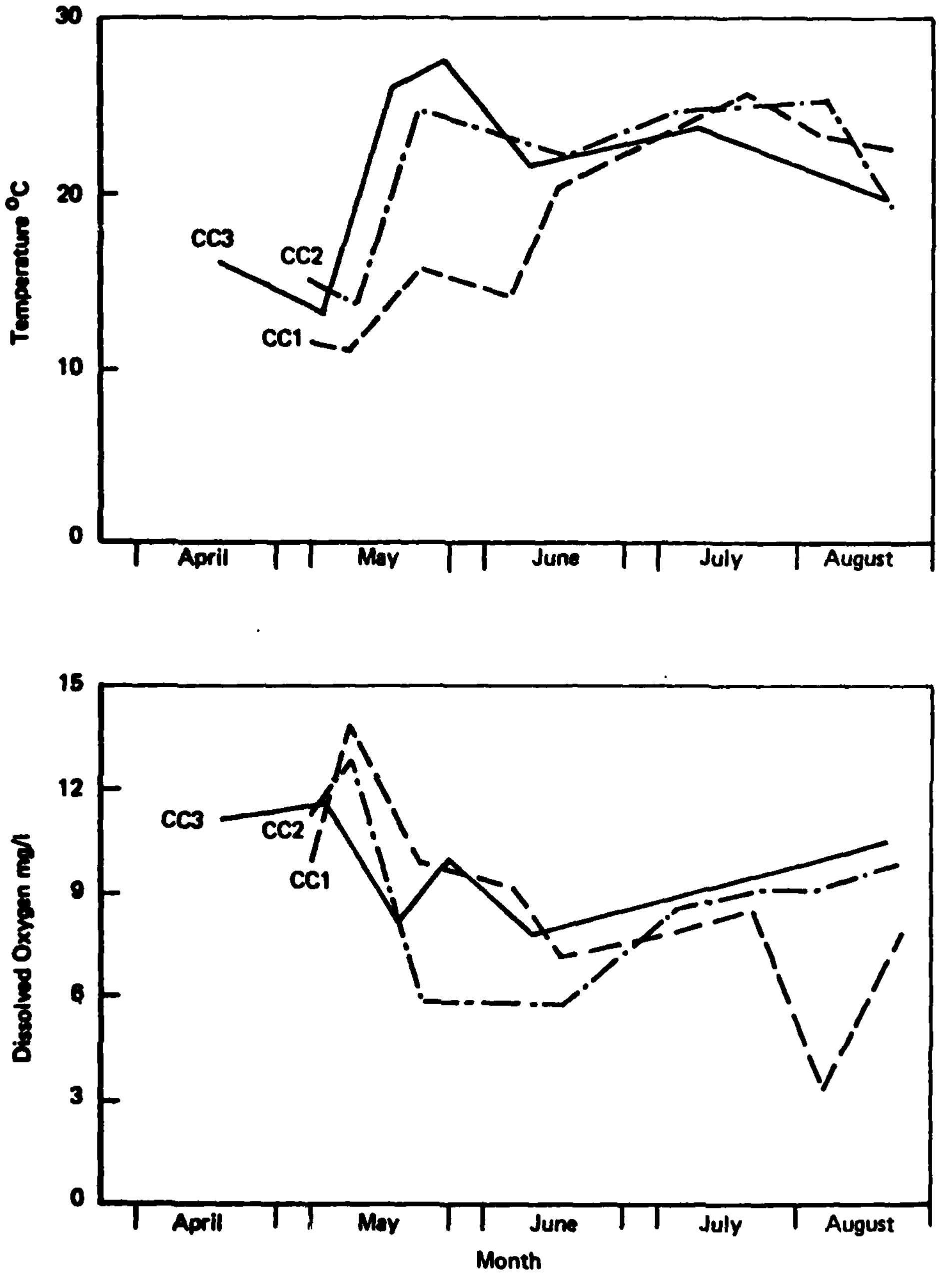
Source: Appendix E.

FIGURE 2–126 LOCATION MAP OF STREAM AND LAKE WATER AND SEDIMENT CHEMISTRY SAMPLING LOCATIONS



Source: Data from Aquatic Ecology Associates, Second Interim Report. (Appendix E).

FIGURE 2–127 COMPARISONS OF TEMPERATURE AND DISSOLVED OXYGEN AT THREE SAMPLING STATIONS ON TURKEY CREEK, APRIL THROUGH AUGUST, 1977



Source: Data from Aquatic Ecology Associates, Second Interim Report.

FIGURE 2–128 **COMPARISONS OF TEMPERATURE AND DISSOLVED OXYGEN AT STATIONS CC1, CC2, AND CC3 IN CONNEAUT CREEK – APRIL THROUGH AUGUST 1977**

Table 2-369

Water Chemistry at Seven Stream Stations for Other Parameters -- April to August 1977

Parameter	Detection Limit	No. of Observations At or Above Detection Limit[1]	Highest Value Seen
Cd	0.01 mg/ℓ	0	-
Cr	0.01 mg/ℓ	0	-
Cu	0.01 mg/ℓ	1	0.01
Hg	0.5 μg/ℓ	0	-
Ni	0.03 mg/ℓ	0	-
Pb	0.03 mg/ℓ	0	-
Zn	0.01	14	0.24
Cn (Tot.)	0.005	1	0.005
$S^=$	0.02	3	0.03

[1] *From a total of 21 observations for each parameter.*

Source: Data from Aquatic Ecology Associates, Second Interim Report

Table 2-370

Chemistry of Surficial Benthic Sediments in Turkey, Raccoon, and Conneaut Creeks -- April 21, 1977

Parameter	Station TC1 (%)	TC3 (%)	TC4 (%)	RC2 (%)	CC3 (%)
NO_2-N	0.001%	0.001%	0.001%	0.001%	0.001%
NO_3-N	0.003	0.004	0.004	0.004	0.004
NH_3-N	0.005	0.005	0.006	0.006	0.014
PO_4-P	0.002	0.001	0.003	0.003	0.001
TKN	0.02	0.04	0.01	0.02	0.11
Cd	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cr	0.0009	0.001	0.0006	0.0006	0.0013
Cu	0.001	0.001	0.0006	0.002	0.002
Fe-TOT	1.9	3.1	1.5	1.8	3.0
Ni	0.002	0.003	0.002	0.002	0.003
Pb	0.002	0.002	0.0003	0.0007	0.002
Zn	0.003	0.010	0.006	0.005	0.009
TOC	0.0055	0.010	0.0014	0.0007	0.0085
Oil	0.026	0.004	0.004	0.004	0.008
Hg	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Source: Aquatic Ecology Associates

g) Future Surface Water Quality Independent of the Proposed Project

Probable Future Water Quality of Lake Erie Independent of the Proposed Project

2.652
The future water quality of Lake Erie in the absence of the proposed plant can be projected on the basis of current trends, and the probable impacts of ongoing pollution control programs. Current trends of increasing dissolved solids and hypolimnion DO depletion rates indicate the likelihood of decreasing water quality despite upgraded control measures. Regarding impact of pollution control program on future water quality a detailed study was made by Dalton, Dalton, Little & Newport (2-191) in accordance with the requirements set forth in the Clean Water Act (CWA). The study considers future water quality in terms of several U.S. Federal control scenarios including best practicable technology, best available technology including combined sewer overflow control, and elimination of discharge of pollutants. Each scenario includes two subcases: with and without control of agricultural runoff. These control scenarios are mandated by CWA for implementation by 1977, 1983, and 1985, respectively. However, best practicable technology goals will not be reached by 1977 due to delay in the construction of sewage treatment plants in major urban areas. The study is limited to consideration of BOD, suspended solids and sediments, and phosphorus loadings. It estimates the effects of the resultant loadings on aquatic life, dissolved oxygen depletion, public water supply, and recreational uses of the lake. The study indicates that control of combined sewer overflow, coupled with best practicable technology would ensure the viability of the lake as a public water supply. Initial reductions in loadings improve water quality, especially in near shore areas, for all scenarios through 1990. According to the study, the quality of the Maumee River basin area and the western basin of Lake Erie can only be improved through control of agricultural runoff. Elimination of dischange with control of agricultural runoff is the only scenario which would reverse the dissolved oxygen problem in the central basin.

2.653
Under baseline conditions, the water quality of the near shore area adjacent to the proposed plant site may be expected to change in a manner similar to that of other nearshore areas as analyzed in the above report. Upgrading of sewage collection and treatment facilities, which has been proposed for Geneva, Northwest Erie County, Conneaut, etc., would probably eliminate the near-shore problems of the area, i.e., bacterial pollution which occasionally renders beaches unqualified for contact recreation. In the event that these improvements are not made, the present problems would undoubtedly worsen as population increases.

2.654
The water quality in the rivers and streams of the Regional Study Area may change in the future, independent of the proposed project, but it is not possible to accurately predict either the direction of change (improvement or deterioration) or the degree of change except for a very few cases. The factors affecting future water quality include: Population changes; Industrial growth; Land use patterns; or constraints on land use; treatment of point source discharges -- degree of control over nonpoint source pollution; Water withdrawals and Construction of impoundments for flood control, water supply, or recreation; and social attitudes towards water quality.

2.655
It is reasonable to expect improvements in water quality in those stream segments downstream of existing point source dischargers to the extent that current Federal (or State) programs will require higher levels of treatment in the future. Also, many segments affected by combined sewer overflows, erosion, dredging, on-lot sewage disposal, solid waste leachate, and vessel discharges show some improvement if present plans are implemented. However, deterioration may occur in those segments that are (or will be) affected by increases in urban runoff, agricultural wastes, the application of road deicing compounds or industrial spills. Increased loadings on existing sewage treatment plants, and the construction of new sewage treatment plants, may be expected as a result of population increases and land use restraints which would continue to limit development outside of sewered areas. Water use may be expected to increase faster than the population if the standard of living continues to increase. Industrial water use, however, has been declining in recent years and is expected to continue to do so. Not all of these water needs will be met by withdrawals from Lake Erie. Inland from the lake surface or ground waters will have to be used, and either way, flows in the streams may be affected. To meet these water needs, and to meet needs or desires associated with recreation and flood control, and the construction of new dams and/or diversions by private interests on the major streams could occur. This would include the Grand and Ashtabula Rivers, and French and Conneaut Creeks. Upground reservoirs could be constructed to withdraw from smaller streams. Any such impoundment or diversion will affect water quality. Since a reduction in total flow of a stream means less assimilative capacity for downstream discharges. One adverse effect on water quality associated with dams is a lowering in the reaeration rate due to slower moving, less turbulent water. This may lead to lowered assimilative capacity for oxygen demanding substances. The streams on the proposed plant site could be expected to undergo little change in water quality in the near future unless the site was developed for other purposes.

Groundwater

2.656
Hydrologic investigations both on site and within the Regional Study Area were performed by the firm of Geraghty and Miller, Inc. (2-192). In addition to determining on site ground water characteristics, this study was also geared toward the Regional Study area to determine whether groundwater supplies in the region would be adequate to meet the drinking water supply needs of an anticipated increase in population. Information on geology, groundwater conditions, and water use was obtained from various Federal and State organizations including the U.S. Geological Survey, the Pennsylvania Department of Environmental Resources, and the Ohio Department of Natural Resources, as well Geraghty & Miller's own research library. Groundwater plays an important part in the water supply of the Regional Study Area. Although the large communities along Lake Erie depend almost entirely on fresh water withdrawn from the lake, about 15 percent of the water used by municipal supply systems in the Regional Study Area is derived from wells and springs. A total of 31 communities depend either fully or in part on groundwater as a source of water. Several large industries in Erie and Crawford Counties use groundwater for cooling and processing, and practically all rural homes are supplied by water from wells.

2.657
Total water use in the three counties is about one million cubic meters per day (300 million gpd) most of which is derived from Lake Erie and used by industry. Groundwater use for public supply, self-supplied industry, and domestic purposes totals 30 million gpd or 12 percent of the water used from all sources. Wells supply 31 public water systems, 100 industries, and 40,000 domestic water installations. The cities of Meadville and Titusville are the largest groundwater withdrawers: 2 million gpd. Large industrial systems using groundwater are the FMC Corporation in Meadville (6,570,000 gpd) and the Cyclops steel plant at Titusville (2,300,000 gpd). Sand and gravel aquifers supply most of this water. The chemical composition of most groundwater supplies in the Study Area is well within U.S. Public Health Service (USPHS) limits for drinking water, except for iron and manganese. Mississippian sandstones yield good quality water, low in chloride and with total dissolved solids concentration in the 200 to 300 mg/1 (200 to 300 ppm) range. Devonian shales often yield water high in chloride and total dissolved solids, exceeding USPHS limits. Most aquifers yield hard to very hard water. With the exception of Ashtabula County, regional groundwater resources are generally adequate to supply future demands for community drinking water systems. Communities along Lake Erie in Ashtabula County already rely on lake water and can simply increase withdrawals

from the lake to meet the additional demand from an increasing population. Elsewhere as other centers of population increase and additional water demands have been determined, detailed hydrogeologic investigations, including test drilling, would be required to determine the feasibility of developing additional groundwater supplies. The Regional Study Area is underlain by sedimentary rocks ranging in age from Cambrian to Pennsylvanian. Bedrock outcrops are rare, because of an extensive cover of Pleistocene material deposited during several states of glaciation that took place in the Great Lakes region.

2.658
Information from 86 on-site borings was reviewed and found to support the geological interpretation of till resting on bedrock. Depths-to-rock also seem to fit a rather uniform pattern, of about 40 to 50 feet below grade for most of the site, but are closer to the surface near the southwestern corner, with outcropping again along Conneaut Creek near the Penn Central tracks. Only the surficial deposits and the uppermost section of the sedimentary rocks are of interest from a groundwater point of view, because of mineralized groundwater at greater depths. Saline groundwater, often containing small quantities of natural gas, 66 to 100 feet below land surface along Lake Erie and 130 to 150 feet below land surface further south. In the Lake Erie region, potable water is restricted to the upper zone of Devonian shales and to Pleistocene beach, outwash, and kame deposits, and sand lenses in moraine material. In the upland areas, important aquifers are the Sharpsville, Berea, and Cussewago Sandstones of Mississippian age. Sand and gravel beds in ancient river valleys (buried valleys) constitute excellent aquifers in Erie and Crawford Counties. Such buried valleys in Ashtabula County contain fine-grained material of low permeability and have little potential for groundwater development. Yields of most wells tapping Devonian shales are 4.8 gpm or less, barely adequate for domestic supplies. The median yield of wells in Mississippian sandstones is 15.9 gpm, while the yield of wells completed in sand and gravel aquifers is as high as 2,060 gpm. Some of the former beach sands along Lake Erie yield as much as 475 gpm. Within the project site, there is no aquifer of any significance and the quality of any water there is generally poor. Water from the Devonian shales is saline Aside from the beach deposits, infiltration of precipitation (or leachate) is very limited. All groundwater flows into Lake Erie, either directly or via one of the streams which cross the proposed plant site. Insofar as the transfer of contaminants to Lake Erie is concerned, surface runoff would be a much more significant factor than groundwater.

a) Regional Water Bearing Characteristics

2.659
The Regional Study Area lies within two different physiographic provinces, the Central Lowland province and the Appalachian Plateau province. The Central Lowland portion lies along Lake Erie and is also called the lake plain. It represents a combination of lake bottom sediments and beach ridges found along the lake margins as the lake stood at successively lower levels during glacial time. The lake plain extends from Lake Erie inland for a distance that varies from 3 to 5 miles and has elevations ranging from the lake level of 570 feet to about 820 feet above sea level. Along Lake Erie, the lake plain terminates as a bluff which rises 82 feet or more above lake level in Erie County, diminishing to about 33 feet above lake level in Ashtabula County. The surface of the lake plain is very flat except for several ancient beach ridges, but in its southern part the land surface is irregular because of moraine deposits laid down by advancing and retreating glaciers. The border between the lake plain and the uplands of the Appalachian Plateau is formed by an escarpment with elevations ranging from about 820 feet to about 980 feet. This strip of land is referred to as the "escarpment slope" in Pennsylvania, where it is a few kilometers wide. Westward into Ohio, the steepness of the slope decreases and the intermediate region becomes less defined. The escarpment slope is formed by thin, erosion-resistant sandstone beds that cap less-resistant shale beds. Northward-flowing streams have cut deep valleys through the escarpment slope exposing bedrock formations.

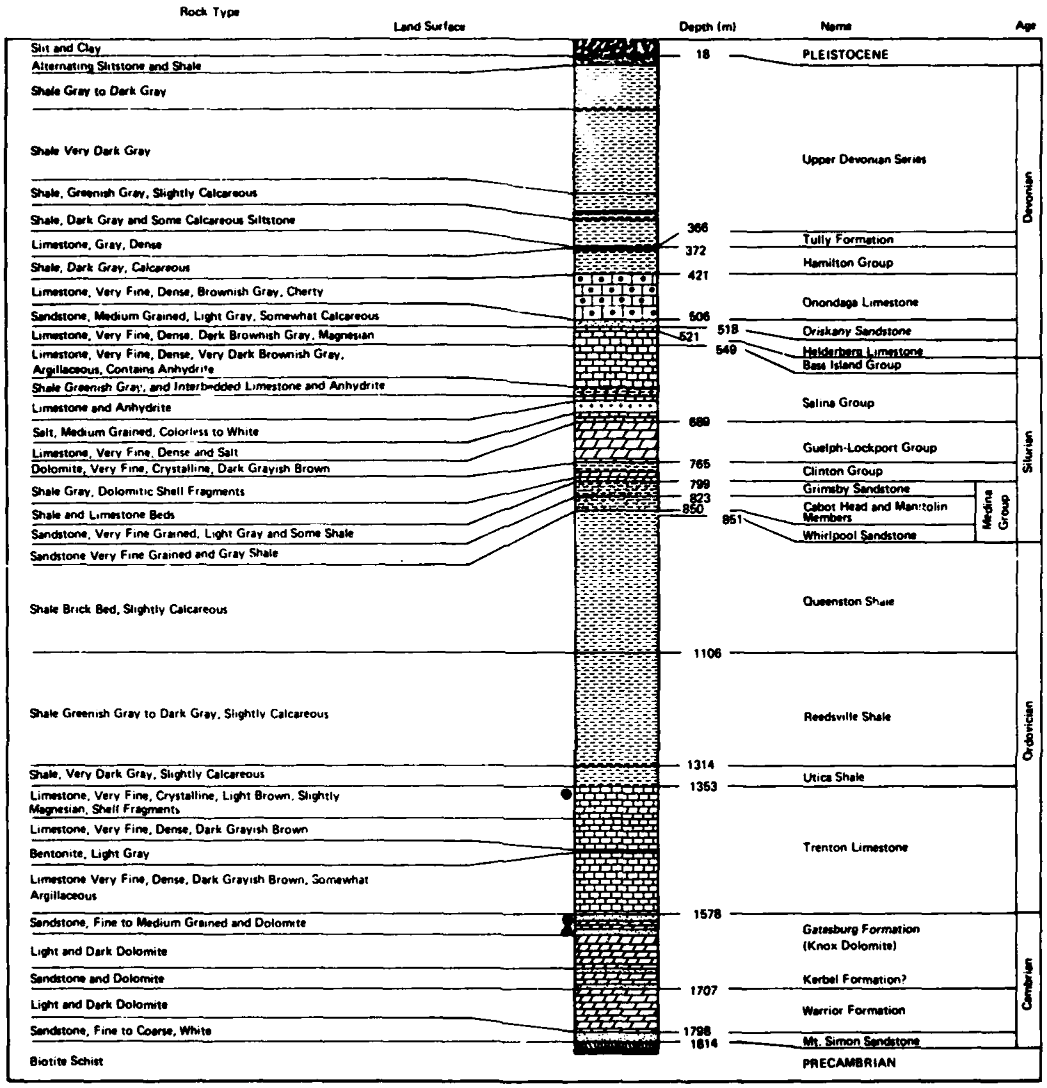
2.660
The major portion of the Regional Study Area lies within the upland plateau, which is the continuation of the glaciated section of the Appalachian Plateau province. The uplands display a gently rolling topography with an incised drainage network. Elevations of the plateau range from 820 to 1,300 feet. North-flowing streams follow broad valleys, 100 to 330 feet deep, exhibiting steep walls and flat floors. South-flowing streams occupy valleys filled with thick deposits of sand and gravel or silts and clays. The topography of the upland area is typical of an eroded plateau partly modified by glacial erosion and deposition. Many areas are poorly drained and swampy, in part reflecting the low permeability of the glacial deposits that cover the bedrock surface.

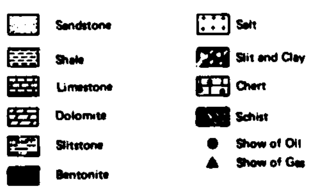
2.661
The Regional Study Area is within the great Appalachian geosyncline, a deep trough filled with over 7.5 mi of Paleozoic sedimentary rocks. In the Ohio-Pennsylvania border area, which lies on the northwest flank of the basin, such sedimentary rocks resting on Precambrian

basement rocks are about 1.1 mi thick. The sedimentary rocks, consisting of sandstone, shale, limestone, and dolomite, dip gently basinward in a southeast direction. The various bedrock units present in the Regional Study Area are shown on Figure 2-129. This stratigraphic column reflects the subsurface conditions at the proposed plant site, and is based on geologic information derived from a deep gas exploratory well drilled in 1941. Subsurface units in the region vary in distribution and thickness, reflecting depositional modes and geologic events that have taken place since the sediments were laid down. Facies changes occur from west to east and crustal movements have produced uplifts, folds, and inconformities. However, the geologic units shown on Figure 2-129 are representative of the entire Regional Study Area.

2.662
From a groundwater point of view, only the uppermost section of the sedimentary rocks is of interest, as most of the deeper rock units contain saline water. Mineralized groundwater containing more than 1,000 ppm of dissolved solids lies at depths of less than 490 feet below land surface in the entire study area. (2-193) In Ashtabula County, the base of potable water lies within 66 to 100 feet below land surface along Lake Erie and about 130 to 165 feet below land surface in the southern part of the county. (2-194) No fresh water zones are found below the saline water, and prospecting for fresh groundwater is thus restricted to unconsolidated deposits and the underlying shallow bedrock. Geraghty and Miller produced a geologic map on a scale of 1:200,000 that shows the distribution of the various bedrock units in the region. Some of the rock units identified in Erie and Crawford Counties have not yet been mapped in Ashtabula County and on the map such units are discontinued at the state line. Two hydrogeologic cross sections through the region were also prepared. One section extends from Conneaut southward through Ashtabula County, and a second section originates at the proposed plant site and crosses southeastward into Erie and Crawford Counties. The geologic sections illustrate typical geological and groundwater conditions in the Regional Study Area.

2.663
Rocks of Upper Devonian age including the Canadaway, Conneaut, and Conewango underlie the entire area. Their combined thickness varies from 990 to 2,100 feet, and most of the stratigraphic section consists of gray shales with minor siltstones and sandstones. The Mississippian System is represented by the Pocono Group, a series of alternating sandstones and shales with a combined thickness of 90 to 300 to 460 feet. Mississippian rocks have been removed by erosion over most of Ashtabula and Erie Counties. Sandstones of the Pocono Group are more resistant than shale, and cap the upland areas in the Regional Study Area. Only one Pennsylvanian rock unit, the





Note: This column shows strata penetrated by the Jay Childs No. 1 well drilled to 5191 feet in 1941 (Fett Ke, 1974.) Section from 5191 pre cambrian basement is projected from well drilled near Erie Pennsylvania (T Omikel and Shepps, 1967).

Source: Geraghty & Miller, Inc., Report of Sept. 15, 1977.

Figure 2-129 Bedrock Column Beneath the Surface at the Proposed Project

Pottsville Formation, is found in the Regional Study Area. It is a fine-grained to coarsely conglomeratic sandstone with minor beds of shale, siltstone, limestone, and coal. The formation caps some of the upland plateau areas in Erie and Crawford Counties and varies in thickness from 35 to 330 feet. Unconsolidated deposits of Pleistocene and Recent age are widespread and cover about 75 percent of the land surface. They include kame and outwash deposits, and lake deposits. The entire region was subjected to several stages of glacial advance and retreat, which deposited a variety of sediments.

b) Regional Groundwater Availability

2.664
Groundwater resources are quite limited in the lake plain area and in Ashtabula County due to geologic conditions. However, in many areas of Erie and Crawford Counties, large groundwater reserves exist that can be utilized for future water requirements. Under natural conditions, groundwater is always in motion from point to recharge to point of discharge or of decreasing head. Ultimate discharge points are springs or rivers that drain the area, or pumping wells. Along the lake plain the ultimate point of discharge is Lake Erie. The rate of groundwater movement is governed by the permeability of the aquifer and the hydraulic gradient. Normal rates of flow are slow, ranging from meters per year to meters per day. However, where natural flows are modified, as by pumping wells, higher velocities occur.

2.665
The availability of groundwater depends on the types of aquifers present, geologic structure, and hydrologic conditions. Precipitation in the region varies from 36 to 45 in. per year. Mean annual precipitation is 36 in. at Ashtabula, 37 in. at Erie, and 38 to 42 in. in the upland area of Erie and Crawford Counties, while the extreme eastern portion of Erie County receives 1,120 millimeters (45 in.) per year. About half of the precipitation returns to the atmosphere by evaporation or vegetative transpiration, and the remaining half becomes available for overland runoff and groundwater recharge. Due to the clayey nature of the soil and the underlying glacial deposits, infiltration of precipitation and groundwater recharge are very low. A study of groundwater yield based on flow duration of streams in the Lake Erie basin indicates that groundwater rechare in the lake plain area is less than 10 gpm/mi^2 increasing to 24 gpm/mi^2 at higher elevations and over areas underlain by glacial outwash in Erie and Crawford Counties. (2-195) Although groundwater recharge rates are low, considerable reserves of groundwater exist in the Regional Study Area. Permeable beach deposits, for example, are recharged directly by precipitation falling on the outcrop area. Sand and gravel in buried valleys store large quantities of water, which is replenished

by slow vertical leakage through overlying fine-grained deposits or glacial till. In addition, sands and gravels in hydraulic connection with lakes or streams can be recharged by induced infiltration from such surface-water bodies.

2.666
Hydrogeologic conditions in the Regional Study Area vary from one area to another because of the nature of individual formations and the varied topography. Since the water-bearing characteristics of rocks vary, information on groundwater is presented according to each geologic unit. The generalized geologic column, including thickness, lithologic description and water-bearing properties of each formation is shown in Table 2-371. The Devonian Rocks, consisting of the Canadaway formation, the Conneaut Group, and the Conewango Group, are predominantly shales and sandstones that yield very small supplies of water. Most of the shale sections are not water bearing, but the sandstone beds are capable of yielding small quantities of water, generally less than 1 litre/sec (16 gpm). The yield of wells penetrating sandstone aquifers depends on the thickness of the sandstone unit: the thicker the sandstone unit, the higher the yield of the well. In the Conewango Group, the Cattaraugus Formation contains three thin sandstone beds, but it appears that these sandstones are missing through erosion or non-deposition in northwestern Crawford County. Where present, such sandstones are poor aquifers. The Ohio Shale (also known as Chagrin Shale) which underlies much of the lower-lying land, including the lake plain, is an important but very poor aquifer. These shales underlie the glacial till deposits over much of the region. The Ohio Shale is important because it is the only source of water over a large region. Potable groundwater is found near the till/shale contact in the uppermost and possibly weathered zone of the shale. At greater depths, the Ohio Shale contains saline water. Yields of wells in the Ohio Shale rarely exceed 16 gpm. Most produce 4.8 gpm or less, a quantity barely adequate for a domestic water supply.

2.667
Records of wells drilled in Ashtabula, Erie, and Crawford Counties confirm low yields of wells tapping Devonian rocks. Occasionally, higher yields are indicated, presumably in areas where the rock is extensively fractured or where the borehole is open to a thicker saturated section. Information on 2,000 water wells in western Crawford County was reviewed to determine typical yields of wells completed in major aquifers. These data are summarized by aquifers, number of wells, range and median yield and range and median specific capacity in Table 2-372. Specific capacity, or yield in litres per second per meter of drawdown, is an indication of the capacity of the aquifer to yield water and is a more useful parameter than the yield of a well, which is often equal to or less than the capacity of the

Table 2-371

General Geologic Column of the Regional Study Area

System or Series		Group or Formation and Map Symbol	Lithologic Description	Thickness (Meters)	Water-Bearing Characteristics
Quaternary	Recent	Alluvium (Qal)	Thin deposits of clay and silt with thin beds of sand and fine gravel	0-5	Of no importance as source of water
Quaternary	Pleistocene	Ground moraine (Qgm) Terminal moraine (Qtm)	Unstratified, heterogeneous deposits of clay, silt, sand, and gravel (Till)	0-60	Sand and gravel lenses in till may yield small amounts of water to wells (less than 0.3 l/s)
Quaternary	Pleistocene	Kame and outwash (Qo)	Stratified sand and gravel deposit	0-150	Most important aquifer in region. Stratified sand and gravel in river valleys (including buried valleys) may yield as much as 130 l/s to wells
Quaternary	Pleistocene	Lacustrine deposits (Ql)	Stratified sand, silt, and clay; beach deposits contain coarse sand and gravel beds	0-20	Lake deposits are generally not water bearing. Beach sands may yield 20 l/s locally
Pennsylvanian		Pottsville Formation (Pp)	Light to dark gray, fine-grained-to-coarsely conglomeratic sandstone with minor beds of gray shale, siltstone, limestone, and coal	10-100	Of no importance as aquifer as mostly unsaturated. Caps Pocono sandstones and shales in southern Crawford County

Table 2-371 (Continued)

System or Series	Group or Formation and Map Symbol	Lithologic Description	Thickness (Meters)	Water-Bearing Characteristics
Mississippian Pocono Group (Mp)	Meadville Shale	Bluish-gray to ashen-gray shale alternating with thin sandstone beds	30	Generally not water bearing
	Sharpsville Sandstone	Thin, hard, limey gray-brown to tan-gray fine-grained sandstone alternating with shales	5-15	Sandstone beds yield up to one l/s to wells
	Orangeville Shale	Soft, fissile dark blue to tan-gray shale	25	Generally not water bearing
	Berea Sandstone	Tan, light gray or white, medium-to-fine-grained quartz sandstone	7-10	Important aquifer in Crawford County; yields up to 2 l/s are possible where sandstone is thickest
	Bedford Shale	Soft, blue-gray shale with thin calcareous sandstone beds in places	15	Generally not water bearing; sandstone beds may yield small amounts of water to wells
	Cussewago Sandstone (White Sand)	Soft, greenish-yellow to greenish-brown, quartz sandstone	10-25	Important aquifer in Crawford County; well yields generally range from 1-3 l/s but may reach 6 l/s

Table 2-371 (Continued)

System or Series	Group	Formation	Group or Formation and Map Symbol	Lithologic Description	Thickness (Meters)	Water-Bearing Characteristics
Upper Devonian	Conewango Group (Dco)		Ohio Shale or Chagrin Shale (Dr) (Riceville Formation in Pennsylvania)	Soft, non-resistant gray to black or blue fissile shale with minor sand lenses	30-300	Generally yields less than 0.3 l/s. Except for uppermost section these shales contain saline water in most areas
		Cattaraugus Formation (Dcr)	Woodcock Sandstone (First Sand)		6	
			Saegertown Shale		30	
			Salamanca Sandstone (Second Sand)	Coarse-grained grayish-white sandstone beds separated by thick shale beds	6	First and second sands missing northwest of Meadville. Third sand is silty and poor aquifer. Shales generally not water bearing
			Amity Shale		40	
			LeBoeuf Sandstone (Third Sand)		7-10	
	Conneaut Group (Dct)		Chemung or Elk Creek Sandstone	Alternating shales and sandstones, fine-grained; gray, fossiliferous	100	
			Girard Shale	Ashen-gray, uniform textured shale	20-70	Generally not water bearing; sandstone beds may yield small amount of water to wells (less than one l/s)
			Canadaway Formation (Dcn) (Northeast Shale)	Alternating gray shales and thin beds of fine-grained gray sandstone	90-150	

Source: Geraghty & Miller, Inc., report of September 15, 1977.

Table 2-372

Yield of Water Wells by Aquifer in Erie and Crawford Counties

Aquifer	Number of Wells	Yield (liter/sec) Range	Yield (liter/sec) Median	Specific Capacity (liter/sec/m) Range	Specific Capacity (liter/sec/m) Median
Crawford County					
Glacial outwash	356	0.1 - 130	1	0.01 - 72	0.2
Sharpsville Sandstone	229	0.1 - 8	1	0.01 - 6	0.2
Cussewago Sandstone	415	0.1 - 8	1.3	0.01 - 7	0.2
Berea Sandstone	134	0.3 - 4	1	0.01 - 5	0.2
Conewango Group	580	0.1 - 4	0.5	0.01 - 2	0.1
Erie County(1)					
Glacial outwash	28	0.1 - 5	0.5	-	-
Glacial moraine	57	0.1 - 5	0.7	-	-
Cattaraugus Formation	63	0.1 - 6	0.4	-	-
Conneaut Group	79	0.1 - 6	0.1	-	-

(1) Domestic wells only

Source: U.S. Geological Survey, 1977 unpublished data and Pennsylvania Geological Survey, 1977 unpublished data compiled by Geraghty & Miller, Inc.

pump installed. As shown in Table 2-372, the 580 wells tapping the Conewango Group in Crawford County ranged in yield from less than 16 to 64 gpm, with a median yield of 8 gpm. The specific capacity of the wells ranged from less than 0.05 to 10 gpm/ft, with a median value of less than 0.5 gpm/ft. A review of data on water wells in Erie County indicates that yields of wells completed in the Devonian are quite comparable. The range in yield of 79 wells tapping the Conneaut Group, and 63 wells completed in the Cattaraugus Formation, is from less than 1.6 gpm to 95 gpm, with median yields of 1.6 gpm and 6.3 gpm, respectively.

2.668
Within the Mississippian Rocks, those comprising the Pocono Group consist of alternating sandstones and shales. The shale units are generally not water bearing, but the Cussewago, Berea, and Sharpsville sandstones are important aquifers in the region, capable of yielding small to moderate supplies of water. The water-bearing characteristics of the Cussewago Sandstone have been studied in detail in Ohio. (2-196) The Cussewago is the most permeable of the three Mississippian sandstones and this is reflected in somewhat better yields and higher specific capacities. In Ashtabula and neighboring Trumbull County, the average yield of 94 wells drilled into the Cussewago Sandstone was 27 gpm; the average specific capacity of 23 Cussewago wells in Ashtabula County was 3.4 gpm/ft of drawdown.

2.669
In western Crawford County, the yield of 415 wells drilled into the Cussewago Sandstone ranged between less than 1.6 gpm and 127 gpm, with a median yield of 20.6 gpm. The median specific capacity of the Cussewago wells was 1 gpm/ft. Water from the Cussewago is generally of good quality but hard and high in iron. The Berea Sandstone is an important aquifer in the region and is tapped by water wells in southern Ashtabula County and in Crawford County. The average yield of 47 Berea Sandstone wells in Ashtabula County was 22 gpm, and the average specific capacity of the wells was 2.4 gpm/ft. (2-196) In Crawford County, the range in yield of 134 Berea wells was 4-60 gpm/ft with a median yield of 16 gpm. The median specific capacity of the Berea wells was 3.2 gpm. In some areas the Berea Sandstone directly overlies the Cussewago Sandstone and the two formations together form a single aquifer with relatively high specific capacity. The quality of water from the Berea Sandstone is generally good, but hard to very hard, with dissolved solids concentrations between 200 to 300 ppm and occasionally high iron content. The water-bearing characteristics of the Sharpsville Sandstone are quite similar to those of the Berea and Cussewago Sandstones. The range in yield of 229 wells completed in the Sharpsville Sandstone in western Crawford County varies from less than 1.6 to 127 gpm, with a median

yield of 16 gpm. The median specific capacity of the wells was 1 gpm/ft. The quality of water from the Sharpsville Sandstone is believed to be similar to that of the other Mississipian sandstone aquifers. Within the Pennsylvanian Rocks, the Pottsville Formation is of little importance as an aquifer because of its limited extent and topographic position. Wherever the formation is saturated, it should be capable of yielding small to moderate supplies of water to wells. However, well data indicating yield and water quality are lacking. Various types of unconsolidated Pleistocene and Recent Deposits are present in the Regional Study Area. Most of the deposits consist of glacial till and fine-grained deposits that are of little or no importance for groundwater supplies. In contrast, stratified and sorted sands and gravels deposited as outwash, valley-train, or kame deposits in the Pennsylvanian portion of the region are excellent aquifers. Together, the formations provide a large reserve of water which is presently almost untapped.

2.670
Outwash and ice-contact deposits of glacial origin are present in many of the present river valleys and in many of the buried valleys of the region. Recent geological investigations by the U.S. Geological Survey in western Crawford County have traced the extent and depth of these buried valleys. (2-197) Other investigations have mapped buried valleys in Erie and eastern Crawford County (2-198), and in northeastern Ohio. (2-199) Sands and gravels within the buried valleys and in the ice-contact deposits are capable of yielding large supplies of water where saturated and an adequate source of recharge exists. Where the aquifers are in hydraulic connection with a river or stream, infiltration of surface water would be possible so that high yields from such wells could be sustained. Examination of well data shows that there are a few large-capacity industrial or municipal wells tapping sand and gravel deposits. Most well records pertain to domestic wells that pump small quantities of water, and do not reflect the larger yield that could possibly be obtained from sand and gravel aquifers. Examination of 356 wells tapping sand and gravel deposits in western Crawford County shows a range in yield of 1.6 to 2,060 gpm, and a median yield of 16 gpm. Specific capacities of the wells ranged from less than 0.05 to 348 gpm/ft with a median specific capacity of 0.2 litre/sec/m. In Erie County, yields of wells tapping glacial outwash material are lower. The range in yield of 28 sand and gravel wells was from less than 1.6 to 80 gpm, with a median yield of 7.9 gpm. Examples of high yields obtainable from buried valley aquifers in Crawford County are the Meadville municipal wells and the nearby FMC plant production wells, which together pump 6,020 gpm or 8.6 MGD from screened sand and gravel wells. The outwash and ice-contact deposits constitute the most important aquifers in the region. The quality of water from the sand and gravel aquifers is good, but frequently the water is hard and

contains excessive concentrations of iron. The lake deposits are generally fine grained and of low permeability and are not considered to be aquifers. The exception is where more coarse material was deposited; for example, as ancient dune or beach deposits or spits. Saturated sands constitute aquifers of local importance, but over most of the lake plain area the beach deposits are thin, only partially saturated, and of no importance as aquifers.

2.671
In Erie County, a number of municipal water systems along Lake Erie are supplied by wells drilled in beach-sand deposits. Among these are Lake City Borough (three wells), Fairview Borough (four wells), the Erie Suburban Division of the Pennsylvania Water Company (19 wells), and the Borough of Girard (three wells). Reportedly, yields of these public supply wells range from 48 gpm to as much as 475 gpm. In Ashtabula County, several large-capacity wells have been completed in a beach-gravel aquifer west of Conneaut. These beach aquifers are exposed and quite vulnerable to contamination. The till deposit sediments are not considered as aquifers, because of the relatively impermeable nature of the till. Occasionally, lenses of sand or gravel are interbedded within the clays and silts, and such permeable zones might yield small supplies of water to wells. In Erie County, the yield of 57 domestic wells completed in moraine deposits ranged from less than 1.6 to 80 gpm, with a median yield of 11.1 gpm. The sand or gravel lenses in the till deposits are of importance in the lake plain area, especially since the underlying shale contains saline water.

2.672
A list of the various aquifers from which water is withdrawn by public supply systems in the Regional Study Area is shown in Table 2-373. The most widely used aquifer is glacial outwash, which provides 7,400,000 gpd from 57 wells and one spring. Next in importance are the Lacustrine deposits along Lake Erie, which supply 1.5 million gpd to 35 wells. The other aquifers in use are interbedded sands and gravels in glacial till as follows: 180,000 gpd, the Berea Sandstone 160,000 gpd, the Pocono Group 106,000 gpd, and the Cattaraugus Formation and the Pottsville Group 2,900 gpd each. An additional 4,000 gpd is derived from unidentified aquifers by the Paul Hudacky Water Company in Erie. Industrial water use for 1976 totaled 183 million gpd for Ashtabula, Erie, and Crawford Counties, with about 170 million gpd from surface-water bodies and 11 million gpd from groundwater sources. Thus, groundwater filled six percent of self-supplied industrial needs in the Regional Study Area (including amounts withdrawn for electric power generation). Industrial pumpage data cannot be subdivided by aquifer, but sand and gravel deposits are believed to supply most of the water. Industries located in Crawford County 10 million gpd from 78 wells and industries in Erie

Table 2-373

Withdrawal of Groundwater by Aquifer for Public Supply in the Regional Study Area in 1976

Aquifer	Number of Wells	Number of Springs	Withdrawal (m^3/d)
Glacial outwash	57	1	28,087
Lacustrine deposits	35	0	5,713
Glacial till	3	3	727
Berea Sandstone	3	0	568
Pocono Group	4	20	447
Cattaraugus Formation	1	0	11
Pottsville Group	0	1	11
Unidentified	0	1	15

Source: Geraghty & Miller, Inc., report of September 15, 1977.

County withdrew one million gpd from 75 wells and 20,000 gpd from nine springs. The largest use of of groundwater by a self-supplied industry is 6,570,000 gpd by the FMC Corporation in Meadville. The next largest groundwater user is the Cyclops steel plant at Titusville, which pumps 2.3 million gpd. Fifteen industries buy water from public supply systems in addition to the amounts withdrawn from their own wells and springs. Self-supplied industries in Ohio do not have to report the amount of water withdrawn to any agency, although the amount of water discharged to the environment must be reported to the Ohio EPA. Thus, no figures are available for industrial/groundwater withdrawal in Ashtabula County. Most self-supplied industries in Ashtabula County are, however, located near Lake Erie and are believed to obtain process water from the lake, because groundwater conditions are unfavorable.

2.673
There are no data regarding quantities of ground water withdrawn for rural domestic use, which includes water from private wells for individual households. However, a rough estimate can be made using housing statistics published by the U.S. Bureau of the Census. The 1970 housing data show that 39,653 houses used private wells in the three counties and 1,519 houses depended on springs or surface supplies. Assuming an average of four persons per household and a water use of 60 gpd (60 gpd for residences with private wells) per capita in this area, the amount of groundwater pumped from private wells is estimated to be about 9.5 million gpd, equal to the quantity of groundwater pumped by public supply systems. Total rural domestic surface-water use, incorporating supplies from springs, is estimated at 370,000 gpd. The areas withdrawing the largest amounts of groundwater are the Meadville-Saegertown area with over 9,800,000 gpd pumped from glacial outwash), Titusville with 4.5 million gpd from glacial outwash, and along Lake Erie east of the city of Erie approximately 2,000,000 gpd from Lacustrine deposits.

c) Regional Groundwater Quality

2.674
The chemical quality of groundwater in the impact area was evaluated by Geraghty & Miller based on 93 chemical analyses listed in published and unpublished documents. Most of the analyses were obtained from computer printouts of groundwater quality provided by the U.S. Geological Survey and by the Pennsylvania Department of Environmental Resources. The results of those chemical analyses tabulated by aquifer are in Table 2-374 while Table 2-375 gives trace metal data compiled from the same sources. The chemical composition of most of the groundwater is well within acceptable limits for drinking water set by the USPHS in 1962, with the exception of iron and manganese. (2-200) The few trace metal analyses reported from

Table 2-374

Groundwater Quality in the Regional Study Area
(Concentrations in mg/1, Except pH)

Aquifer and Period of Record	pH			Hardness ($CaCO_3$)			TDS (residue at 180°C)			Chloride (Cl)			Fluoride (F)		
	N	R	M	N	R	M	N	R	M	N	R	M	N	R	M
Glacial Till (1974)	2	7.0	-	2	130-158	-	1	384	-	2	3.0- 36	-	2	0.06-0.07	-
Glacial Outwash (1971-74)	21	6.9-8.2	7.6	17	120-282	214	12	178- 412	350	21	4.0- 71	20	20	0.04-0.39	0.09
Lacustrine Deposits (1972-73)	29	6.7-8.0	7.3	28	149-538	254	19	240-1,100	384	28	15 - 315	50	26	0.05-0.33	0.08
Pocono Group (1974)	2	7.0-7.3	-	2	152-156	-	2	256- 260	-	2	7.0	-	2	0.09-0.12	-
Berea Sandstone (1954-?)	1	7.3	-	2	191-244	-	3	213- 312	272	3	4.0- 6.0	4.0	1	2.0	-
Cussewago Formation (1966-71)	9	7.3-9.3	8.1	1	38	-	8	197- 382	253	9	1.0- 42	9.0	9	0.19-0.59	0.50
Cattaraugus Formation (1970-71)	3	7.0-7.8	7.5	1	258	-	2	165-6,190	-	3	6.0-3,530	11	2	0.39-0.59	-
Conneaut Group (1951)	9	7.5-8.0	7.8	0	98-256	168	1	491	-	9	7.0- 179	50	1	0.29	-
Canadaway Formation (1951)	17	6.2-7.7	6.8	17	38-312	98	2	241- 491	-	17	7.0-1,170	95	2	0.2 -0.3	-
USPHS Drinking Water Standards (1962)		-			-			500			250			1.7 [a]	

Aquifer and Period of Record	Iron (Fe)			Manganese (Mn)			Sulfate (SO_4)			Nitrate (NO_3-N)		
	N	R	M	N	R	M	N	R	M	N	R	M
Glacial Till (1974)	2	0.06- 0.30	-	1	0.06	-	1	107	-	2	0.29-0.53	-
Glacial Outwash (1971-74)	21	0.01- 3.1	0.13	16	0.01-0.22	0.06	16	11- 81	40	14	0.01-1.3	0.18
Lacustrine Deposits (1972-73)	28	0.06-30	0.45	17	0.07-1.5	0.05	18	42-530	64	28	0.04-1.9	0.55
Pocono Group (1974)	2	0.02	-	2	0.02	-	2	39- 40	-	-	-	-
Berea Sandstone (1954-?)	3	0.35- 1.3	0.36	-	-	-	3	8.4- 27	22	1	0.44	-
Cussewago Formation (1966-71)	10	0.01- 0.90	0.05	6	0.02-0.16	0.06	7	6.0- 35	12	8	0.03-0.51	0.09
Cattaraugus Formation (1970-71)	3	0.11-38	0.50	2	0.12-0.70	-	2	13- 15	-	[illegible]	0.06-0.09	-
Conneaut Group (1951)	1	1.3	-	-	-	-	1	18	-	1	5.5	-
Canadaway Formation (1951)	2	6.6 - 9.2	-	-	-	-	2	17- 80	-	2	0.2-0.3	-
USPHS Drinking Water Standards (1962)		0.3			0.05			250			10	

N - Number of samples
R - Range
M - Median (In the case of an even number of samples, the average of the two middle values was taken as the median value.)

a) Recommended control limit based on air temperature data.

Sources: U.S. Geological Survey, Feb. 20, 1976, "Storet Printout of Ground-Water Analyses," U.S. Geological Survey, Harrisburg, Pennsylvania.
Bureau of Water Quality, Feb. 20, 1976, "Storet Printout of WAMIS Ground-Water Analyses," Pennsylvania Department of Environmental Resources.
Rau, J.L., 1969. "Hydrogeology of the Berea and Cussewago Sandstones in Northeastern Ohio," U.S. Geological Survey Hydrogeologic Investigations Atlas HA-341.
Mangan, J.W., et al. 1952, "Water Resources of the Lake Erie Shore Region in Pennsylvania," U.S. Geological Survey, Circular 174.

Table 2-375

Trace Metal Concentrations in Groundwater in Erie and Crawford Counties (Concentrations in mg/l)

	Glacial Outwash					Berea Sandstone	Cussewago Formation
Constituent	Pa. State Fish Hatchery (1964)	Meadville MWW Well 1(1) (1972)	Meadville MWW Well 3 (1972)	Titusville MWW Well 1 (1972)	Canadohta Water Association Wells 3, 403,702 (1972)	Jamestown MUA (1954)	Jamestown Water Co. (1966)
Aluminum	0.027	2.7	2.9	0.10	0.14	0.00	0.008
Arsenic, inorgnic	-	0.00	0.00	0.00	0.00	-	-
Barium	0.55	0.50	0.50	0.50	0.50	-	0.02
Beryllium	0.001	-	-	-	-	-	0.003
Bismuth	-	-	-	-	-	-	0.005
Boron	0.091	0.00	0.00	0.00	0.00	-	0.44
Cadmium	-	0.005	0.003	0.003	0.003	-	0.01
Chromium	0.003	0.03	0.02	0.00	0.00	-	0.01
Cobalt	0.002	0.00	0.00	0.00	0.00	-	0.01
Copper	0.001	0.00	0.00	0.00	0.00	0.00	0.002
Gallium	-	-	-	-	-	-	0.001
Germanium	-	-	-	-	-	-	0.005
Lead	0.002	0.05	0.05	0.05	0.05	-	0.01
Lithium	0.037	0.50	0.50	0.05	0.05	1.40	0.02
Mercury	-	-	-	-	0.0005	-	-
Molybdenum	0.003	0.10	0.10	0.25	0.25	-	0.002
Nickel	0.001	0.00	0.10	0.03	0.05	-	0.007
Rubidium	0.001	-	-	-	-	-	0.005
Silver	0.00	0.00	0.00	0.00	0.00	-	0.002
Strontium	0.14	-	-	-	-	-	0.14
Tin	0.003	0.50	0.50	1.0	1.0	-	0.014
Titanium	0.009	0.20	0.20	0.50	0.50	-	0.01
Vanadium	0.001	0.50	0.50	0.25	0.25	-	0.012
Zinc	0.07	0.05	0.00	0.03	0.03	0.00	0.70
Zirconium	0.003	-	-	-	-	-	0.025

(1) Methylene blue active substances detected in this sample at a concentration of 0.03 mg/l.

Source: U.S. Geological Survey, Feb. 20, 1976, "STORET Printout of Ground-Water Analyses," U.S. Geological Survey, Harrisburg, Pennsylvania.
Bureau of Water Quality, Feb. 20, 1976, "STORET Printout of WAMIS Ground-Water Analysis," Pennsylvania Dept. of Environmental Resources.

wells tapping glacial deposits and sandstones in Erie and Crawford Counties do not show concentrations exceeding USPHS recommended limits for drinking water. However, lead concentrations in four of the five glacial outwash samples were at the recommended limit of 0.05 ppm. Most of the aquifers yield hard to very hard water; of 93 chemical analyses, 65 had hardness concentrations over 120 ppm and 42 were over 180 ppm.

2.675
Sand and gravel aquifers usually yield water that is somewhat higher in dissolved solids, hardness, and sulfate than bedrock aquifers. However, as previously noted, the Devonian bedrock, including shales and siltstones of the Cattaraugus Formation, the Conneaut Group, and the Canadaway Formation contains hard water with concentrations of chloride and total dissolved solids often exceeding USPHS limits for drinking water. Those shales, which are covered by glacial till deposits, contain saline water at fairly shallow depth and often yield small quantities of natural gas. The chemical quality of water tapped by wells in the Devonian shale will vary widely depending on the depth and location of the well. Generally, the deeper the well, the more mineralized the water. For this reason, wells tapping shale bedrock are usually completed in the uppermost portion of the aquifer. Concentrations of total dissolved solids of 29 wells in Devonian shales ranged from 165 to 6,190 ppm, and chloride concentrations ranged from 6 to 3,530 ppm. Iron and manganese concentrations in practically all shale wells were above USPHS recommended limits for drinking water. The Berea and Cussewago Sandstones of the Pocono Group generally yield water of good quality that is low in chloride. Total dissolved solids concentrations are normally in the 200 to 300 ppm range, and chlorides are usually less than 10 ppm. However, iron and manganese concentrations are frequently above USPHS limits.

2.676
Nitrate concentrations, useful as indicators of possible pollution from fertilizers or waste disposal in groundwater, are well below USPHS recommended limits. Although there is no evidence of regional contamination of ground water, some of the detailed water analyses that were reviewed indicate possible local degradation of water quality. The sand and gravel aquifers exposed at the land surface, such as the beach deposits along Lake Erie and outwash and kame deposits in the stream valleys, are extremely vulnerable to pollution from man's activities on the land surface. Fractured bedrock aquifers are also subject to degradation. Pollution of groundwater may occur, for example, from improper waste disposal from spills of chemicals and hydrocarbons, and from highway deicing salts. Other potential sources of pollution are numerous abandoned oil and gas exploratory wells. Due to either lack of casing or corroded pipe,

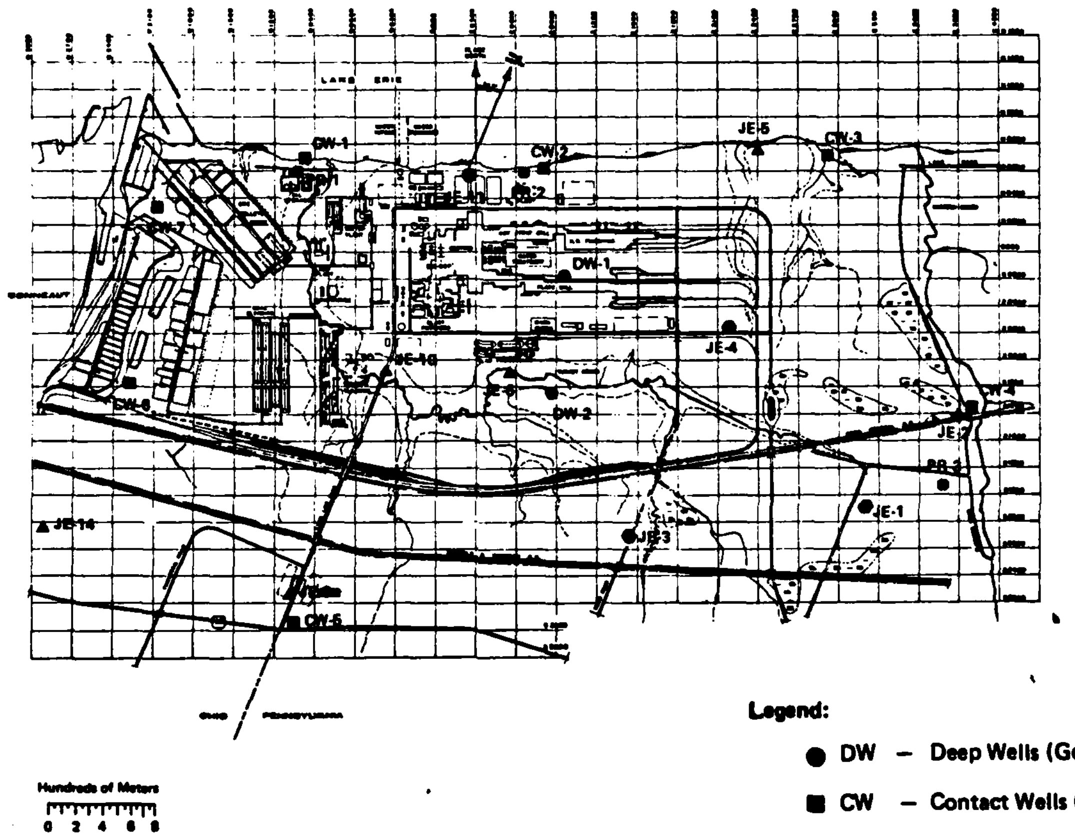
brines from deep formations may move upward in a borehole to discharge into and possibly pollute shallower formations that bear fresh water. Once an aquifer is polluted, it is virtually impossible to restore its natural water quality. A large number of soil-boring records were examined. The older records are concentrated in the Ohio third of the site and therefore give an incomplete picture, with most of the Pennsylvania site untested, except for the old Perry Bluff ore storage area. An effort was made to determine if any borings were still in existence for water-level measurements or sampling, but the only ones remaining are from the latest D'Appolonia/Haley & Aldrich joint effort. There are a number of shallow domestic wells supplying cottages along the lakefront, but there are no data available for those. In general, the permeability of the earth materials beneath the site is so low that very little percolation of precipitation takes place, and swampy surface conditions and extensive puddling of water follows rainfall or snow melt.

d) On-Site Water-Bearing Characteristics

2.677
A review was made of published data; geologists, drillers and other professionals were contacted to obtain first-hand information about the site geology from borehole observations, logging, and water-level data. Site geology and hydrology were mapped by Shepps (2-201) and described by Leggette. (2-198) Their work indicates an absence of suitable aquifer materials within the boundaries of the site. Glacial till and Lacustrine deposits, consisting chiefly of silt and clay, overlie shale bedrock and are generally less than 50 feet thick. Some sand and gravel deposits (Pleistocene beach ridges) are found in the area. (2-202) These are usually underlain by till and do not constitute an aquifer of practical value within the site. Some glacial outwash and stream deposits of high permeability are reported in the region, but none are known at the site. For the most part, Lake Erie shore communities derive their potable water supplies directly from the lake or from other surface sources. (2-203) The Ohio portion of the site, which is included on an Underground Water Resources Map (2-204) has water well yields of less than 4.8 gpm from both bedrock and overlying unconsolidated deposits.

e) On-Site Groundwater Availability

2.678
Nine exploratory wells were selected. Two wells (DW-1 and DW) are located north and south of the Perry Bluff ore storage area. Seven wells averaging 50 feet deep (CW-1 to CW-7) were drilled to the unconsolidated deposits-bedrock contact. The location of these wells is shown in Figure 2-130. The well DW-1 was drilled into the shale



Legend:

- ● DW – Deep Wells (Geraghty & Miller)
- ■ CW – Contact Wells (Geraghty & Miller)
- ● PR – Privately Owned Wells
- ▲ JE – Observation Wells (Haley & Aldrich)
- ● JE – Piezometers (Haley & Aldrich)

Source: Geraghty & Miller, Inc., Report of Sept. 15, 1977.

FIGURE 2–130 LOCATION OF GROUNDWATER EXPLORATORY WELLS AT THE PROPOSED PROJECT SITE

bedrock to a depth of 184 feet. The materials penetrated were mostly quite dry. A well was drilled to 150 feet at site DW-2 on Childs Road through overburden and shale bedrock. Well site DW-2, in contrast to DW-1, produced an estimated 1.6 gpm of fairly salty water, which filled the open hole quickly. Well CW-2 was drilled near the shore, just north to Lake Road, about midway between east and west property lines, and well CW-1 was drilled near the Lake and Thompson Roads intersection. Wells CW-1, CW-2 and CW-3 were located near Lake Road for the establishment of water-level and water-quality control along the shore. Wells CW-4 and CW-5 were located in hydrologically upgradient areas, where high water levels were expected. They were also located in proximity to existing Wells JE-2 and JE-9 for water-level comparisons between the different screened depths. Wells CW-6 and CW-7 were drilled along the western site boundary adjacent to Conneaut Creek. CW-6 was sited on filled land through a buried soil profile which may represent the original Conneaut Creek bank, while CW-7 was sited near the ore storage area in the extreme northwestern corner of the site. After completion of drilling, water levels were measured in the newly drilled and existing wells to note the rate at which stabilization of water in casings appeared to take place. These data are presented in Table 2-376. Wells CW-2, CW-3, and CW-7 seemed to recover most poorly, while CW-4, CW-5, and CW-6 responded quite rapidly. Wells CW-3 and CW-7 remained dry. A pumping test was carried out on Well DW-2, which had filled with water quite rapidly after drilling. A submersible pump, set near the bottom of the well, discharged water at about 3.2 to 4.8 gpm. A somewhat salty water sample was obtained and later shipped to the laboratory for analysis. It was difficult to regulate the discharge, especially with increasing drawdowns and corresponding discharge head. However, a 0.15 litre/sec yield, as originally estimated by the driller on completion of the well, seems a reasonable estimate under sustained, constant pumpage. All observation wells were sampled using a small-diameter bailer to obtain about 2.4 gpm of water from each well. Specific conductance and pH were measured in the field, and a portion of each sample was filtered through a Millipore membrane to insure accurate analysis for metals. Chemical fixing agents necessary for sample preservation were included in the appropriate containers. In total, 15 samples were analyzed.

2.679
The groundwater flow pattern beneath the site is generally towards the lake, with Turkey Creek and Raccoon Creek acting as drains (refer to Figure 2-131). The drain effect of the creeks is based largely on mapped intersections of surface contours and the creeks themselves. This is reasonably valid at moderately low stages, but not at stages reflecting surface runoff or at times of no flow. Raccoon Creek, at least, shows no flow on many days (2-205) and at such times it may not act as a drain, depending on whether or not there is groundwater

Table 2-376

Water Levels in Wells Drilled at the Proposed Project Site

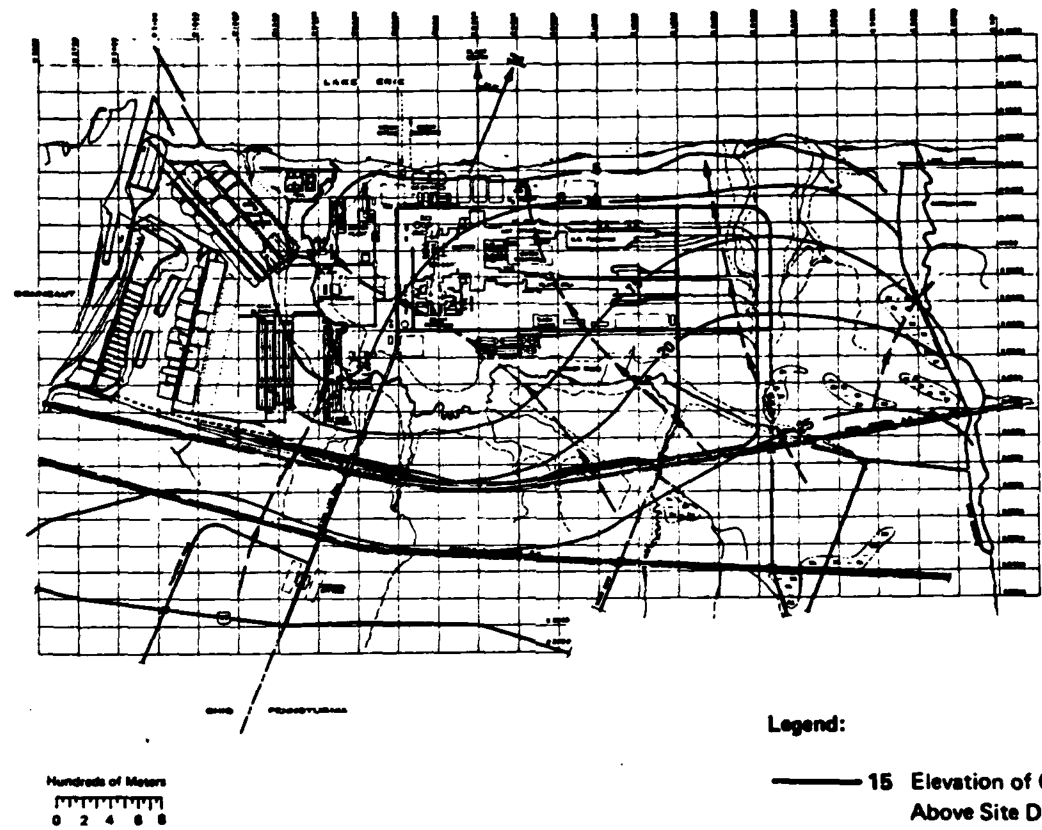
Water Elevations in Meters (above site datum[a])

1977 Date		2-25	3-7	3-8	3-9	3-10	3-11	4-13	4-15	4-25	4-26[b]	4-26[c]	4-27[d]	4-28	M.P. Elevation
CW-1	-	-	-	-	-	-	-	-2.89	-2.11	-0.40	-0.33	dry	-	-	15.43
CW-2	-	-	-	-	-	-	-	2.26	2.36	2.64	2.67	-3.35	-3.28	-	15.76
CW-3	-	-	-	-	-	-	-	dry					dry	-	9.70
CW-4	-	-	-	-	-	-	-	23.31	23.62	23.88	23.89	18.15	22.81	-	26.46
CW-5	-	-	-	-	-	-	-	28.78	30.79	30.97	30.98	20.92	24.92	-	32.47
CW-6	-	-	-	-	-	-	-	0.93	0.87	1.00	1.02	0.98	1.00	-	6.22
CW-7	-	-	-	-	-	-	-	dry	1.16	-	-	-	4.86	-	9.24
DW-1	-	-	-	-	-	-	-	-	-35.6	-	-	-	-9.17	-	20.40
DW-2	-	-	-	-	-	-	-	15.19	-	15.30	-	-	-	-	22.04
JE- 1 e)		25.6	25.0	25.26	25.30	25.36	25.30	-	-	-	-	-	-	-	26.2
JE- 2	18.7 f)	24.6	24.7	24.78	24.74	24.79	24.8	24.79	24.68	24.82	24.82	18.51	19.43	20.20	25.4
JE- 3 e)	25.0 g)	25.1	24.9	24.93	25.1	24.10	25.1	-	-	-	-	-	-	-	25.7
JE- 4 e)	21.9	21.9	21.7	21.73	21.7	21.73	21.7	-	-	-	-	-	-	-	22.4
JE- 5	8.6 f)	7.2	6.9	7.02	7.03	7.04	7.00	6.89	6.88	6.83	6.95	3.74	5.40	-	9.4
JE- 6	15.9 h)	19.1	19.0	19.13	19.16	19.17	19.2	19.26	19.26	19.30	-	17.31	-	-	20.5
JE- 9	29.4 i)	29.4	29.1	29.25	29.24	29.23	29.2	29.20	29.14	29.35	29.44	-	29.33	-	30.3
JE-10	-	11.3	10.6	10.77	10.73	10.65	10.6	10.34	10.28	11.09	11.07	-	10.29	-	12.6
JE-11 e)	-	15.2	14.8	14.77	14.8	14.76	14.8	-	-	-	-	-	-	-	15.5
JE-14	-	21.4	25.6	-	-	25.95	25.8	26.05	26.04	-	26.20	-	23.25	-	26.5
Measurement Source	H&A[j]	H&A	H&A	H&A and G&M[k]	H&A and G&M	H&A	H&A	G&M	G&M	G&M	G&M	G&M	G&M		

a) Site datum: 0 meters = 173.89 meters above mean sea level.
b) Before air pumping
c) After air pumping
d) Before sampling
e) Piezometer
f) 2-21-77
g) 2-19-77
h) 2-18-77
i) 2-24-77
j) H&A: Measurements taken by Haley & Aldrich as part of the D'Appolonia/Haley & Aldrich Joint Effort
k) G&M: Measurements taken by Geraghty & Miller

Note: Measurements taken from Haley & Aldrich report are to nearest 0.1 meter.
Measurements taken during Haley & Aldrich-Geraghty & Miller field operations are given to the nearest 0.1 meter.

Source: Geraghty & Miller, Inc., report of September 15, 1977.



Legend:

—— 15 Elevation of Ground Water in Meters Above Site Datum (Site Datum 0 = 173.89 m Above M.S.L.)

→ → Direction of Ground-Water Flow

Source: Geraghty & Miller, Inc., Report of Sept. 15, 1977.

FIGURE 2–131 GROUNDWATER CONTOURS AT THE PROPOSED PROJECT SITE

flow. There is no doubt that the shape of the groundwater contours will change somewhat from season to season and that all of the shallow groundwater (at least) discharges, ultimately, into Lake Erie. A reasonable estimate of the volume of groundwater that would enter Lake Erie, after having passed beneath an area of potential contamination, would amount to only 594 gpd. Unless significant quantities of some highly toxic substance were leaching into the groundwater, such discharge could cause no problem with lake water quality.

2.680
Except for snow melt and releases from reservoirs, dry-weather flow in streams (known as base flow) derives entirely from groundwater. Thus, it is possible to evaluate the storage characteristics of the watertable aquifer by analyzing streamflow data. These characteristics will be referred to as "available groundwater storage" since permeability is at least as important as storage volume. Saturated clay contains more water than does saturated sand, but the water in the clay is, for all practical purposes, unavailable to support stream flow. The available groundwater storage characteristics of the shallow, watertable deposits through which a stream flows are indicated by the shape and (particularly) the slope of the flow-duration curve at its lower end. If the storage characteristics are poor, as for till, the low-flow end of the curve will be steep and reflect very low flow per unit area. On the other hand, if the water flows through an area of sand and gravel, the base flow will be well-supported by ground-water storage, and the low end of the flow-duration curve will be relatively flat and show a high flow.

f) On-Site Groundwater Quality

2.681
The results of chemical analyses of groundwater samples taken during the field program are given in Table 2-377, and selected ion ratios are given in Table 2-378. Aside from several of the shallow wells, none of the well meets USPHS standards in all respects although lead concentration at this well is near the maximum allowable limit. The lowest water quality water observed in wells DW-1 and DW-2, specific conductance measured at each well was 65,500 and 25,050 mhos/in., repectively. The considerable difference in water quality in two wells only some 2,800 feet apart, and of roughly the same depth, illustrates the problems encountered in interpreting water quality data from the site. The lower concentration of dissolved solids in the water from DW-2 is explained by an influx of shallow water at the 17-meter (56-ft) level, which was not encountered in DW-1. The latter produced only small quantities of water, all from the deeper shales. Water from the CW-series wells, taken just below the contact of the Quaternary sediments with the shale, is poorest in quality at

Table 2-377

Results of Chemical Analysis of Groundwater Taken at the Proposed Lakefront Plant Site

Water Quality Parameter	Units	Sample Identification														
		BW1	BW2	CW2	CW4	CW5	CW6	CW7	JE2	JE5	JE6	JE9	JE16	PR1	PR2	PR3
pH (Field)[1]	-	6.4	7.1	6.3	6.5	6.5	6.4	6.3	6.0	6.0-6.5	6.8	6.5-7.0	6.6	6.3	6.6	6.7
Temperature (Field)[1]	°C	16	10.6	10	9	11	11	11	9	9	12	11	11	9	12	18
Specific Conductance (Field)	umhos/cm	8000	8000	6500	2100	2000	1650	5500	700	1700	780	-	1590	310	900	600
Alkalinity	mg/l as $CaCO_3$	106	444	312	220	71.0	142	92.3	181	176	204	146	195	31.0	92.0	131
Bicarbonate	mg/l	129	542	381	268	86.6	173	113	221	215	249	178	238	37.8	122	160
Carbonate	mg/l	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloride	mg/l	9497	3050	1600	480	411	144	1050	67.5	311	101	111	289	13.0	170	53.0
Cyanide	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	mg/l	0.13	0.40	0.34	0.50	0.47	0.26	0.29	0.50	0.72	0.55	0.15	0.43	0.14	0.22	0.20
Nitrogen-Ammonia	mg/l	19.0	6.2	N.A.[2]	1.4	1.5	1.4	2.5	1.3	2.4	1.6	0.3	1.3	0.1	0.3	0.4
Nitrogen-Nitrate	mg/l	0.4	0.1	N.A.	0.1	<0.1	<0.1	<0.1	0.2	0.5	0.6	0.1	0.2	<0.1	<0.1	0.3
pH	-	5.97	N.A.	6.28	6.73	6.61	6.46	6.44	6.45	6.60	6.57	6.50	6.56	6.65	6.68	6.70
Phenol (Distillation)	mg/l	0.02	<0.01	N.A.	0.04	N.A.	N.A.	0.02	N.A.	0.12	N.A.	N.A.	N.A.	N.A.	<0.01	N.A.
PCB's	mg/l	<0.0002	<0.0002	N.A.	<0.0002	N.A.	N.A.	<0.0002	N.A.	<0.0002	N.A.	N.A.	N.A.	N.A.	<0.0002	N.A.
Specific Conductance	@ 25° C umhos/cm	25000	9870	5110	2110	2090	1460	4340	719	1780	784	793	1600	273	961	613
Sulfate	mg/l	3.0	6.0	86.0	11.0	230	410	370	60.0	220	16.5	85.0	145	75.0	75.0	60.0
Metals (Dissolved):																
Cadmium	mg/l	0.03	0.02	N.A.	0.01	N.A.	N.A.	0.02	N.A.	0.01	N.A.	N.A.	N.A.	N.A.	<0.01	N.A.
Calcium	mg/l	662	144	190[3]	39.0	68.0	142	238	66.0	100	82.5	83.5	106	30.0	32.8	30.2
Chromium	mg/l	0.06	0.04	0.02[3]	<0.01	<0.01	0.01	0.02	0.03	0.02	0.03	0.04	0.06	0.01	0.01	<0.01
Iron	mg/l	5.55	5.60	0.32[3]	0.01	0.04	0.98	0.05	11.8	5.48	6.60	23.5	14.5	0.15	0.33	0.40
Lead	mg/l	0.20	0.06	0.10[3]	0.04	0.02	0.02	0.07	0.02	0.09	0.01	0.04	0.09	0.05	0.04	0.05
Magnesium	mg/l	210	47.5	31.2[3]	6.2	6.8	41.5	41.2	13.2	26.0	8.8	10.2	23.5	8.3	3.5	5.5
Manganese	mg/l	0.45	0.28	4.75[3]	0.53	0.50	3.78	0.22	1.16	0.96	0.50	1.16	2.19	0.02	0.08	0.18
Mercury	ug/l	0.7	2.4	N.A.	<0.5	N.A.	N.A.	<0.5	N.A.	1.4	N.A.	N.A.	N.A.	N.A.	<0.5	N.A.
Nickel	mg/l	0.09	0.10	N.A.	<0.01	N.A.	N.A.	0.03	N.A.	0.04	N.A.	N.A.	N.A.	N.A.	<0.01	N.A.
Potassium	mg/l	62.5	18.6	10.0[3]	3.5	4.7	6.0	8.0	6.6	13.6	3.0	2.5	8.1	0.71	4.6	2.4
Sodium	mg/l	2900	1730	710[3]	390	310	92.5	445	28.5	163	24.0	21.8	138	4.7	48.0	14.5
Zinc	mg/l	0.07	0.71	26.5[3]	2.25	0.57	5.90	45.5	29.0	8.20	3.00	19.5	30.5	0.04	0.09	3.60
Date of Sampling - 1977		4-27	4-14	4-28	4-27	4-27	4-27	4-27	4-28	4-27	4-27	4-27	4-27	4-27	4-27	4-27
Time of Sampling		1600	1330	0800	1000	1100	1800	1705	0730	0915	1200	1130	1430	1900	1930	2000
Date Received by Lab - 1977		4-29	4-15	4-29	4-29	4-29	4-29	4-29	4-29	4-29	4-29	4-29	4-29	4-29	4-29	4-29

(1) Field values were obtained at the time of sampling by Geraghty & Miller personnel.

(2) N.A. = Not Analyzed.

(3) Values for CW2 are total (unfiltered) values; no filtered sample was provided.

Source: Geraghty & Miller, Inc., report of September 15, 1977.

Table 2-378

Ion Ratios in Water Samples Taken at the Proposed Project Site

Sample Identification	Ca:Mg	Cl:SO_4	Na:K
DW-1	3.15	3,165	68
DW-2	3.04	508	94
CW-2	6.08	16.3	71
CW-4	6.29	43.6	111
CW-5	10.0	1.79	66
CW-6	3.42	0.35	15
CW-7	5.77	2.84	56
JE-2	5.01	1.12	4.3
JE-5	3.84	1.41	12
JE-6	9.36	6.12	8.0
JE-9	8.20	1.30	8.7
JE-14	4.72	1.99	17
PR-1	3.61	0.17	6.6
PR-2	3.86	2.27	10
PR-3	5.50	0.88	5.8

Note: Ratios are based on mg/l.

Source: Geraghty & Miller, Inc. report of September 15, 1977.

CW-2 and CW-7. Well CW is on the lake shore and CW-7 is on Conneaut Creek near its mouth, which suggests that the lake front is a discharge area for the more saline water this is found deeper in the shales. The data are consistent with the concave-upward flow lines found near discharge areas, but additional studies would be necessary to establish this supposition as a fact. Three private wells that were damples (PR-1, 2, and 3) were all shallow dug wells, with concrete or brick linings. It is reported that they respond quickly to rainfall, and that the quality of water deteriorates (to taste) during dry periods. The analytical results obtained probably represent near-maximum quality because of snow melt prior to the sample period.

2.682
Water quality data for water samples taken from Conneaut Creek and Raccoon Creek at periods of base flow (i.e. when stream flow comes from groundwater storage) is presented in Table 2-379. The general quality of Conneaut Creek water is distinctly superior to that from Raccoon Creek, with the chloride content being markedly lower. This is undoubtedly due to groundwater contributions from sand and gravel aquifers in the upper reaches of Conneaut Creek. There is also apparently some deterioration in water quality in Raccoon Creek in the reach between the gaging station and the lake. Otherwise the data are unremarkable, except that the quality of water is generally superior to the average in situ shallow groundwater. This is probably because base flow even in Raccoon Creek is largely supported by seepage from the permeable sediments, in which the water is less highly mineralized than that in the low permeability sections.

Water Use

a) Introduction

2.683
The water in the Regional Study Area occurs within a system consisting of three principal interconnected components: atmospheric moisture, surface water, and groundwater. Since a percentage of the total precipitation is consumed by evapotranspiration and because the system reflects changes in weather and climate, the water available for use is smaller than the total amount of water in the system. The concentration of population, commerce and industry in the Regional Study Area has placed many demands upon the water resource and has created a situation in which most elements of the Regional Study Area's water resource serve more than one water use. Within the Regional Study Area, water is used for domestic, public/commercial, industrial, agricultural sewage disposal, power cooling, navigational, recreational, and other uses including fish and wildlife

Table 2-379

Base-Flow Water Quality Data for Conneaut and Raccoon Creeks

	Conneaut Creek		Raccoon Creek			
Sampling Station	1		2		3	
Date	10-8-75	8-30-76	10-8-75	8-30-76	10-8-75	8-30-76
Discharge (cu m/sec)	N/D	0.31	N/D	0.006	N/D	0.042
Specific Conductance (μmhos/cm)	225	320	468	443	455	583
pH	7.9	7.6	7.2	6.9	7.2	7.3
Iron	0.15	0.29	0.51	0.33	0.40	0.43
Manganese	0.03	0.05	0.10	0.08	0.11	0.15
Hardness (as $CaCO_3$)	N/D	128	N/D	123	N/D	180
Alkalinity (as $CaCO_3$)	N/D	124	N/D	126	N/D	156
Sulfate	N/D	40	N/D	5.8	N/D	36
Chloride	N/D	19	N/D	89	N/D	97

Sampling Stations:

1. Conneaut Creek at West Springfield on Cherry Hill Road.
2. Raccoon Creek at gaging station near West Springfield.
3. Raccoon Creek at bridge on Lake Road.

Quality data, except pH, given as mg/1.
N/D = Not determined.

Source: U.S. Geological Survey, Meadville, Pennsylvania, 1977.

habitat. Water can be classified into three major categories: withdrawal uses, transport or flow uses, and in-place uses. (2-206)

2.684
Withdrawal uses are those which require water to be diverted from its position in the water system. After use, the water is returned to the water system, although its quality, quantity, and location may have been changed significantly. For example, water withdrawn from storage in an aquifer is discharged after use for domestic or other purposes into a surface stream where it becomes available for reuse. Withdrawal uses may include: domestic, public/commercial, agricultural, and industrial water uses. Leakage of water from central water supplies must also be accounted for as withdrawn water.

2.685
Transport or flow uses require both a continuing inflow of water and an available place downstream to receive water after use, as typified by streamflow. These flows of water are used, for example, to transport sewage effluent and heat, to carry shipping, and to generate hydropower. Transport uses may include: waste load, power cooling and surface water runoff uses.

2.686
In-place uses depend on volumes or areas of water, rather than on water movement. For example, recreational uses require the availability of water whose quantity can be measured in units of area or perimeter. Flood control, on the other hand, requires space in reservoirs or river plains and depends on the absence of water. Both of these uses can be considered as essentially "in-place." In-place uses include: water-oriented recreation, navigation, flood control as a volume requirement, and fish and wildlife habitat. The water uses defined above are not mutually exclusive. For example, water may be withdrawn from a stream or a reservoir by an industry for cooling, the main flow could be used to transport wastes and heat downstream, and the surface could be the scene of recreational boating and fishing. Thus, water use of whatever type does not generally mean consumption of the water, but rather using it for a specific purpose and then discharging it to become available for other uses (reuse). Exceptions are some of the water withdrawn for irrigation and about 10 percent of the water withdrawn by industry which is evaporated and not returned to the same region. All remaining water used is available for reuse. Water used for withdrawal purposes is generally expressed in million gallons per day (GD); transport water is also expressed in terms of flow, i.e. cubic feet per sec. (cfs); whereas water for in-place uses is expressed in acres, acre-feet, or other relevant units. The objective of the following sections is to provide a summary of the principal water withdrawals from different sources within the Regional, Principal, and Local Study Areas. A

summary only of the remaining water uses is included, because such information is given in other chapters of this study (e.g., sewage systems, surface runoffs, navigation, recreation, etc.). Data available from different sources are not always in agreement. Therefore, for the same water use, different information sources have been compared and the most reasonable values have been presented.

b) Withdrawal Uses

2.687
Withdrawal uses are supplied from public water supply systems, from private systems that draw water from wells, from surface streams, reservoirs or lakes. In many cases, either public or private supplies may be obtained from more than one source.

Domestic Use

2.688
Water withdrawn for drinking, sanitation and other household purposes as well as for swimming pools is considered to be used for domestic purposes. Domestic water is usually supplied by either central water supply systems or by individual wells. Central water supply systems, both publically and investor owned, supply nearly 70 percent of the population in the Regional Study Area. There are over 30 centralized supply systems which range in capacity from 0.014 MGD (Kent Water Supply, Crawford County) to as high as 88.0 MGD (City of Erie, Bureau of Water). Most of the water supply in the Regional Study Area is obtained from either Lake Erie or from groundwater, with very little supply obtained from reservoirs. There are no accurate data regarding quantities of water withdrawn for domestic water use, which include water from private wells for use by individual households. (2-207) However, an overall estimate of per capita water use can be made using 1975 population data presented in Table 2-380 and the per capita 1975 water use estimates in Table 2-381. The population (weighted total water use unit requirements (gallons per capita per day, GPCD) in 1975 are: Local Study Area, 79.57 GPCD; Principal Study Area; 80.85 GPCD, Regional Study Area 80.89 GPCD). For the different study areas, the estimated domestic water use values for the baseline year (1976) are given below. Values in MGD were obtained by multiplying the baseline population of the area by the domestic water use unit requirements.

Regional Study Area

Ohio:	102,000 X 81.44	=	8.31 MGD
PA:	356,600 X 80.73	=	28.79 MGD
	Total	=	37.10 MGD (1975)

Table 2-380

Baseline Population Data for the Regional Study Area -- 1975

Ohio[1]		Pennsylvania	
Local Study Area	14,700	Local Study Area	3,200
Conneaut City	14,700	Springfield Township	2,650
Principal Study Area[2]	74,950	E. Springfield Borough	550
Ashtabula City	24,300	Principal Study Area[2]	256,350
Ashtabula Township	7,600	Conneaut Township	2,050
Denmark Township	800	Elk Creek Township	1,600
Kingsville Township	4,700	Fairview Township	
Monroe Township	1,900	and Borough	8,500
Pierpont Township	1,050	Girard Township	
Plymouth Township	2,300	and Borough	6,150
Saybrook Township	6,700	Lake City	2,300
Sheffield Township	1,300	Millcreek Township	39,000
Regional Study Area	102,000	Platea Borough	350
		Regional Study Area	356,600

Total Population

- Regional Study Area 458,600
- Principal Study Area 331,300
- Local Study Area 17,900

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(1) Townships in Ohio include villages (e.g., Kingsville Township includes North Kingsville Village)

(2) Principal Study Area includes the Local Study Area plus townships not listed separately.

Source: Arthur D. Little, Inc. estimates.

Table 2-381

Estimated Domestic Water Use Unit Requirements -- 1975 in the Regional, Principal and Local Study Areas (Gallons Per Capita Per Day)

Study Areas	Population(1)	Water Use Unit Requirement(2)
Local Study Area		
Ohio		
Conneaut City	14,700	81
Pennsylvania		
Springfield Township & Borough	3,200	73
Total	17,900	79.57
Principal Study Area		
Ohio		
Local Study Area	14,700	81
Ashtabula City	24,300	81
Ashtabula Township	7,600	89
Kingsville Township	4,700	89
Saybrook Township	6,700	73
Rest of Principal Study Area	16,950	81
Sub-Total	74,950	81.60
Pennsylvania		
Local Study Area	3,200	73
Fairview Township & Borough	8,500	73
Girard Township & Borough	6,150	81
Millcreek Township	39,000	81
Rest of Principal Study Area	199,500	81
Sub-Total	256,350	80.63
Total	331,300	80.85
Regional Study Area		
Ohio		
Principal Study Area	74,950	81.60
Rest of Regional Study Area	27,050	81
Sub-Total	102,000	81.44
Pennsylvania		
Principal Study Area	256,350	80.63
Rest of Regional Study Area	100,250	81
Sub-Total	356,600	80.73
Total	458,600	80.89

(1) See Table 2-380.

(2) Refer to Chapter 2, Water Supply section. Total Water Use Unit Requirements are population weighted.

Source: Arthur D. Little, Inc. estimates based upon data from Ashtabula and Erie County Planning Commissions.

An alternative estimate for domestic water use in Erie County, was 26.66 MGD for 1971 (1.902 MGD, domestic water use publically supplied from groundwater; 22.423 MGD, domestic water use publically supplied from surface water; 2.336 MGD, domestic water use self-supplied from groundwater = 26.66 MGD.). (2-209) This estimate equals 92.6 percent of the value given above (28.79 MGD) for the domestic water use in the Pennsylvania portion (Erie and Crawford) of the Regional Study Area in 1975 (28.79 X 92.6% = 26.66 MGD) and was considered as too high.

Principal Study Area

The total estimated weighted domestic water use unit requirement (Table 2-381) equals 80.85 GPCD.

The overall 1975 domestic baseline water use would thereby equal

331,300 X 80.85 = 26.79 MGD (1975)

Local Study Area

Using the weighted total domestic water use unit requirement of Table 2-382, the overall 1975 domestic baseline water use would equal

17.900 X 79.57 = 1.42 MGD (1975)

In summary, the estimated volume of water used for domestic supply is as follows (Table 2-384):

- Regional Study Area	37.10 MGD (1975)
- Principal Study Area	26.79 MGD (1975)
- Local Study Area	1.42 MGD (1975)

Public/Commercial Use

2.689
Water withdrawn for public buildings, schools, fire, and other public purposes is considered to be a public/commercial water use. There are no adequate data regarding quantities of water used for these purposes, and values of water use from different sources are often contradictory. For the Regional Study Area and the different counties, the following values were found in the literature:

Ashtabula County (2-208)

For 1969, 5.08 MGD were used. It was assumed that the annual increase from 1969 to 1970 was negligible and the 1969 value was adopted for 1970: 5.08 MGD (1970)

Table 2-382

Agricultural Water Use Baseline Projections in the Regional, Principal, and Local Study Areas -- 1970-1990[1]
(Millions of Gallons per Day)

	1970	1975	1980	1990
Regional Study Area				
Erie/Crawford Counties	9.66	15.82	21.98	26.00
Ashtabula County	1.23	1.45	1.66	1.74
Total	10.89	17.27	23.64	27.74
Principal Study Area				
Erie/Crawford Counties	4.83	7.91	10.99	13.00
Ashtabula	0.62	0.73	0.83	0.87
Total	5.45	8.64	11.82	13.87
Local Study Area	No reliable estimates can be given.			

[1] Includes crop irrigation, livestock, and golf course irrigation.

Source: Arthur D. Little, Inc. estimates.

Erie County (2-209)

For commercial/institutional purposes in 1971, 4.95 MGD was used. Assuming negligible annual increase, the 1970 value was assumed to be equal to 1970: 4.95 MGD (1970)

Crawford County (no data available)

An estimate would be 70 percent of the value (70 percent is an Arthur D. Little, Inc. estimate, based on the public activities in the Pennsylvania Regional Study Area) for Erie County, or
0.70 X 4.95 MGD = 3.47 MGD (1970)

Total 13.50 MGD (1970)

Thus, in 1970, 13.50 MGD were used for public/commercial purposes in the Regional Study Area. Updating this estimated value to 1975 by assuming an annual increase of two percent (proportionate to baseline population increase between 1970 and 1975) the public/commercial baseline water use estimate for 1975 would be 14.90 MGD or approximately 15.0 MGD (1975). Thus, in 1975, total Public/Commercial water use for the Regional Study Area was 15.0 MGD. This corresponds to 40.5 percent (15 x 100/37.10 = 40.5%) of the calculated consumption for domestic water use requirements for the same area. The estimate is independently corroborated by considering related water use values presented in the Water Supply Working Paper appended to this statement. Although different sources have been considered in estimating those values. Thus, the final estimates for the public/commercial baseline water use in 1975 are as follows (Table 2-384):

- Regional Study Area = 15.00 MGD (1975)

- Principal Study Area

  15.00 X 26.79/37.10 = 10.83 MGD (1975)

- Local Study Area

  15.00 X 1.42/37.10 = 0.57 MGD (1975)

Leakage Use

2.690
Leakage was estimated to be about 10 percent to 20 percent of the total quantity of water withdrawn for domestic and public/commercial water supplies, based on studies conducted in the midwest (e.g.,

Chicago, Illinois). Assuming that a factor of 10 percent would be applicable for the different study areas, then (Table 2-384):

- Regional Study Area

  (37.10 + 15.00) X 0.10 = 5.21 MGD (1975)

- Principal Study Area

  (26.79 + 10.83) X 0.10 = 3.76 MGD (1975)

- Local Study Area

  (1.42 + 0.57) X 0.10 = 0.20 MGD (1975)

A.ricultural Use

2.691
Although agriculture appears to account for a relatively small withdrawal volume related to the categories considered, it is significant because virtually all of the water is not available for "immediate" reuse. Data are sketchy regarding water use for agriculture (including livestock and golf course irrigation) in the different study areas, and the estimated baseline projections listed in Table 2-383 should be considered as rough. Data sources are as follows:

<u>Erie, Crawford Counties</u> (2-210, 211)

For crop irrigation, livestock and golf irrigation, total agricultural water use in the Principal Study Area has been estimated to total 4.83 MGD in 1970, 10.99 MGD in 1980 and 13.00 MGD in 1990. (2-245) The Principal Study Area is approximately half as big as the Regional Study Area within the Pennsylvania Study Area, and therefore, for agricultural water use in the Regional Study Area was assumed to be twice that in the Principal Study Area:

9.66 MGD in 1970 (2 X 4.83 = 9.66)
15.82 MGD in 1975*
21.98 MGD in 1980 (2 x 10.99 = 21.98)
26.00 MGD in 1990 (2 x 13.00 = 26.00)

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* Estimate equals to the mean of 1970 and 1980 due to the lack of other data, or 9.66 + 21.98/2 = 15/82 MGD (1975) for the Pennsylvania Regional Study Area and 15.82/2 = 7.91 MGD (1975) for the Pennsylvania Principal Study Area.

Table 2-383

Agricultural Water Use Baseline Projections in Northeast Ohio and Ashtabula County[1]
(Millions of Gallons per Day)

	1969		1980		1990	
	Northeast Ohio	Ashtabula	Northeast Ohio	Ashtabula	Northeast Ohio	Ashtabula
• Crop Irrigation	3.21	*	11.41	0.69	12.78	0.82
• Livestock	3.19	*	3.01	0.66	2.81	0.61
• Golf Course Irrigation	5.54	*	5.54	0.31	6.45	0.31
Total Water Use	11.94	1.19	19.96	1.66	22.04	1.74
	1.19 = 10% of total 11.94		1.66 = 8.31% total 19.96		1.74 = 7.89% total 2204	
			Annual Increase 3% (Ashtabula County)		Annual Increase 1% (Ashtabula County)	

(1) "Northeast Ohio Water Plan, Technical Report, Plan Formulation and Alternatives," Ohio Department of Natural Resources

*No reliable data available.

Source: Arthur D. Little, Inc. estimates.

Ashtabula County (2-208)

Information regarding agricultural water use baseline projections for crop irrigation, livestock, and golf irrigation for Ashtabula and Northeast Ohio,** is listed in Table 2-383. For Northeast Ohio 02-2420 estimates total 11.94 MGD in 1969, 19.96 MGD in 1980 and 22.04 MGD in 1990. For Ashtabula, agricultural water use requirements total 1.66 MGD in 1980 and 1.74 MGD in 1990 or 8.31 percent (1.66 = 8.31 X 19.96) and 7.89 percent (1.74 = 7.89% X 22.04), respectively, of the Northeast Ohio's agriculture water use requirements. No data are available for Ashtabula in 1969, however, it is estimated to be 10 percent*** of the total 1969 requirements in Northeast Ohio or 1.19 MGD (10% X 11.94 = 1.19 MGD, 1969).

Annual increases of approximately three percent and one percent are estimated for the agricultural water use in Ashtabula and the time periods 1969-1980 and 1980-1990, respectively. Data are listed in Table 2-382. The 1970 estimate (1.23 MGD) in the table results from the annual increase of three percent over the 1969 value (1.19 x 1.03 = 1.23 MGD). Annual increase is also shown in the table. Assuming agricultural water use in the Regional Study Area is proportionate to that in Ashtabula County, agricultural water use (Table 2-382) is estimated to be 10.89 MGD in 1970 (9.66 MGD Erie/Crawford County; 1.23 MGD Ashtabula County), 17.27 MGD in 1975* (15.82 MGD Erie/Crawford County, 1.45 MGD Ashtabula), 23.64 MGD in 1980 (21.98 MGD Erie/Crawford County, 1.66 Ashtabula County) and 27.74 MGD in 1990 (26.00 Erie/Crawford County, 1.74 Ashtabula). For the Principal Study Area (Table 2-382) in Ashtabula one-half of the given estimates are taken into account (using the surface area ratios mentioned earlier).

Industrial Water Use

2.692
Water withdrawals for industrial processing and employee sanitary uses (but not for cooling) are considered to be an industrial water use. Industries (including mining industries) use some public water, but supply much of their needs from privately developed sources

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* Estimate equals to the mean of 1970 and 1980 due to the lack of other data, or 9.66 + 21.98/2 = 15.82 MGD (1975) for the Pennsylvania Regional Study Area and 15.82/2 = 7.91 MGD (1975) for the Pennsylvania Principal Study Area.

** 12 Counties given in Reference 2-242.

*** 10% estimate results from a linear extrapolation of the 1980's (8.31% out of total 22.04) and 1970's (8.31% out of total 19.96) values, or: (8.31% - 7.89%) X (20 - 11.94) (22-20) + 8.31% = 10%.

(wells, lakes, etc.). Industrial usage accounts for the largest withdrawal volumes in the Regional Study Area; however, most industrial processes actually consume only a small portion of the water. The remainder is discharged and theoretically available for reuse. While data are sketchy regarding industrial water use, it is estimated that approximately 225 MDG were required in 1975 in the Regional Study Area. Data sources include the following:

Ashtabula County (2-207, 208, 212)

Self-supplied industries in Ohio do not have to report the amount of water withdrawn to any agency, although the amount of water discharged to the environment must be reported to the Ohio EPA. Thus, no figures are available (2-207) for industrial pumpage or withdrawal in 1970 in Ashtabula County. Most self-supplied industries in Ashtabula are located near Lake Erie and are believed to obtain process water from Lake Erie. The industrial water demand projections for Ashtabula County are (2-208) 184.6 MGD in 1980 and 158.8 MGD in 1990. Given that the total industrial water demand projections in Northeast Ohio are 1,324 MGD in 1969, 1,226 MGD in 1980 (Ashtabula's participation 15% = 184.6 X 100/1,226) and 1,195 MGD in 1990 (Ashtabula's participation 13% = 158.8 X 100/ 1,195), it is reasonable to assume that the industrial water demand for Ashtabula County in 1969 (and/1970) was slightly higher than the demand would be in 1980. Assuming a 14 percent participation of Ashtabula in the total Northeast Ohio industrial water demand (14% = average of 13% (1990) and 15% (1980)), it is reasonable to estimate 185 MGD (14% X 1,226 = 185) for 1969, which leads to the conclusion that industrial water use for Ashtabula County will be approximately constant and equal to 185 MGD for 1970 to 1980.

Erie County (2-209)

Within Erie County, approximately 90 industries were identified which withdrew approximately 30 MGD in 1971. (2-243) Given that no major industries have moved into this Area between 1971 and 1975 and the lack of data for 1975, 30 MGD is a reasonable estimate for industrial water use in the period 1970 to 1975.

Crawford County (2-207)

No data exist for industrial water use in Crawford County. Geraghty & Miller, Inc., estimated a total consumption of 10 MGD in 1970. (2-207) No major industries have moved into this area between 1970 and 1975 and thus, 10 MGD would be a reasonable estimate for 1970 to 1975.

2.693
Summarizing, a total industrial water use of 225 MGD* would appear to represent a reasonable estimate for the Regional Study Area for 1970 to 1975. Given that only six percent of the industrial water use (2-207) in the Regional Study Area is withdrawn from groundwater, the remaining 94 percent being withdrawn from Lake Erie, we may assume that the industrial zone is close to Lake Erie and closely resembles the Principal Study Area. Therefore, the previous estimate (25 MGD) may be equally accurate for the Principal Study Area. The existing data are very sketchy regarding the industrial water use in the study areas and different estimates for the Principal Study Area would be as accurate as the value given (225 MGD)**. As an example, Geraghty & Miller, Inc., reports a total industrial water use for 1970 and 1976 of 182 MGD in Ashtabula, Erie, and Crawford Counties. (2-208) This corresponds to approximately 80 percent of the total estimate (80% X 255 = 180 MGD) and is approximately equal to the industrial water use given for Ashtabula County (184.6 MGD, 1980). (2-208) Industrial demands in Erie and Crawford Counties total, according to the previous estimates, 40 MGD (1975) (Erie, 30 MGD; Crawford, 10 MGD), in the Regional Study Area. This estimate is very close to the one given for the Principal Study Area in Erie and Crawford Counties

* 225 MGD - Ashtabula, 1985 MGD (1970 to 1980); Erie County, 30 MGD (1970-75): Crawford County, 10 MGD (1970-75).

** It must be pointed out that only 9.5 MGD (36,000 m3/d) are withdrawn from groundwater for different industries located outside the Principal Study Area and within the Regional Study Area in Erie and Crawford Counties. (2-207,212)

in the latest "Northwest Area Profile" report (39.99 MGD* in 1975) (2-211) which leads to the conclusion that industrial water uses in the Regional and the Principal Study Areas in Pennsylvania total about 40 MGD and different estimates would not be more accurate. Therefore, a total industrial water use of 225 MGD in 1975 would appear to present a reasonable estimate for the Regional Study Area as well as the Principal Study Area. No analytic data exist for the industrial water use baseline projections in Erie and Crawford Counties. However, for the Principal Study Area in Erie/Crawford Counties (2-211), industrial water use of 35.31 MGD (1980), 33.08 MGD (1990) is reported. In Ashtabula County, 184.6 MGD (1980) and 158.8 MGD (1990) is estimated. Thus, the industrial water use baseline projections for the Regional Study Area (and also the Principal Study Area) would be: 225 MGD for 1975; 219.91 MGD = 220 MGD for 1980 (219.91 = 184.6 + 35.31) and 191.88 = 192 MGD for 1990** (191.88 = 158.8 + 33.08). These estimates are summarized in Table 2-385.

Total Withdrawal Uses

2.694
Total withdrawal uses in the Regional Study Area ar estimated to have been approximately 300 MGD in 1975 (=1.13 million m^3/day). This estimate agrees quite well with that independently given (=1.00 million m^3/day) by Geraghty and Miller, Inc. (2-207) Estimates for the different uses in 1975 are summarized and listed in Table 2-384.

* Industrial water use 44.68 MGD (1970), 35.31 MGD (1980). Average for 1975, equals 39.99 MGD 91975) =
$$\frac{44.68 \text{ MGD } (1970) + 35.31 \text{ MGD } (1980)}{2}.$$

** In Ohio (and this may be true for other areas) the fraction of industrial water supplied from public sources of supply will increase from 16 percent in 1969 to 51 percent by 2020; however, the industrial fraction of public water demand will decrease from 40 percent in 1969 to 33 percent in 2020. Overall, the total industrial water requirement will decrease as a result of recirculation by 36 percent.

2.693
Summarizing, a total industrial water use of 225 MGD* would appear to represent a reasonable estimate for the Regional Study Area for 1970 to 1975. Given that only six percent of the industrial water use (2-207) in the Regional Study Area is withdrawn from groundwater, the remaining 94 percent being withdrawn from Lake Erie, we may assume that the industrial zone is close to Lake Erie and closely resembles the Principal Study Area. Therefore, the previous estimate (25 MGD) may be equally accurate for the Principal Study Area. The existing data are very sketchy regarding the industrial water use in the study areas and different estimates for the Principal Study Area would be as accurate as the value given (225 MGD)**. As an example, Geraghty & Miller, Inc., reports a total industrial water use for 1970 and 1976 of 182 MGD in Ashtabula, Erie, and Crawford Counties. (2-208) This corresponds to approximately 80 percent of the total estimate (80% X 255 = 180 MGD) and is approximately equal to the industrial water use given for Ashtabula County (184.6 MGD, 1980). (2-208) Industrial demands in Erie and Crawford Counties total, according to the previous estimates, 40 MGD (1975) (Erie, 30 MGD; Crawford, 10 MGD), in the Regional Study Area. This estimate is very close to the one given for the Principal Study Area in Erie and Crawford Counties

* 225 MGD - Ashtabula, 1985 MGD (1970 to 1980); Erie County, 30 MGD (1970-75): Crawford County, 10 MGD (1970-75).

** It must be pointed out that only 9.5 MGD (36,000 m3/d) are withdrawn from groundwater for different industries located outside the Principal Study Area and within the Regional Study Area in Erie and Crawford Counties. (2-207,212)

Table 2-384

Total Withdrawal Uses in the Regional, Principal, and Local Study Areas -- 1975
(Millions of Gallons Per Day)

Water Uses	Regional Study Area	Principal Study Area	Local Study Area	% of Total Water Use for the Regional Study Area
Domestic	37.10	26.79	1.42	12.38%
Public/Commercial	15.00	10.83	0.57	5.01
Leakage	5.21	3.76	0.20	1.74
Sub-total	57.31	41.38	2.19	19.13%
Agriculture	17.27	8.64		5.76
Industrial[1]	225.00	225.00	-	75.11
Total	299.58 ≅ 300 MGD	275.02 ≅ 275 MGD		100.00%

Total withdrawal approximates 300 MGD ≅ 1.13 million m^3/day.

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[1] Because local data are unavailable, estimates for industrial withdrawals in the Local Study Area were not made. Industrial water use in the Principal Study Area is estimated to be equal to the industrial water use for the Regional Study Area as discussed earlier in this section.

Table 2-385

Population and Water Use Baseline Projections for the Regional, Principal, and Local Study Areas -- 1975-1990

	1975	1981	1986	1990
Population				
Regional Study Area	458,600	478,300	493,800	506,200
Principal Study Area	331,300	343,240	354,180	362,900
Local Study Area	17,900	18,595	19,300	19,800
Domestic/Commercial Public/Leakage Water Use (MGD)				
Regional Study Area	57.31	59.77	61.71	63.26
Principal Study Area	41.38	42.87	44.24	45.33
Local Study Area	2.19	2.28	2.36	2.42
Agriculture Water Use (MGD)				
Regional Study Area	17.27	24.05	26.10	27.74
Principal Study Area	8.64	12.02	13.05	13.87
Local Study Area	No reliable estimates can be given.			
Industrial Water Use (MGD)				
Principal Study Area (1)	225	128	133	192
Power/Cooling Water Use (withdrawal MGD)				
Regional Study Area	600	No reliable estimates can be given.		
Principal Study Area	127	127	132	137

(1) Rounded numbers for 1981 and 1986.

Source: Arthur D. Little, Inc. estimates.

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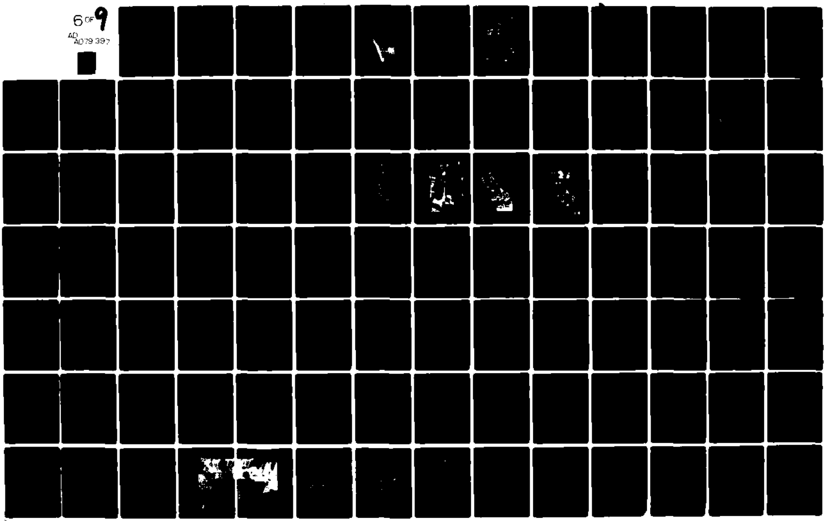


Sources of Supply

2.695
Both surface water and groundwater are used to supply municipal, industrial, and other uses. It is estimated that in 1975 about 36 MGD (12% X 300 MGD) of the total water use in the Regional Study Area was supplied from groundwater sources and 264 MGD (88% X 300 MGD) from surface water sources, the principal source being Lake Erie. Despite its relatively small contribution, groundwater nevertheless plays an important role in the water supply of the Regional Study Area and is the sole source for 31 public water systems, over 100 self-supplied industries and some 40,000 domestic water installations. Withdrawals of water by public supply systems in Ashtabula, Erie, and Crawford Counties during the 1975-1976 period were given in the Water Supply section and discussed further in the Surface Water section of this chapter. Aside from Lake Erie, and groundwater withdrawals, a few streams are tapped for local water/irrigation supply. The villages of Rock Creek and Geneva obtain small quantities of water from the Grand River. The Pymatuning Reservoir is not used for water supply but is operated to regulate flow in the Shenango River for flood control and recreation. Public supplies using inland surface water in Ashtabula, Erie and Crawford Counties total about 4.2 MGD (0.016 million m^3/day at 1.35 percent of the total withdrawal).

Power-Cooling Use

2.696
The large volumes of water withdrawn by industries and utilities for cooling are usually returned to the source after use. Power-cooling water resource uses were classified earlier in this section under the transport use. Power-cooling water uses, as a withdrawal, are discussed below. Power cooling uses for Ashtabula County were 443 MGD in 1969 (2-208) and for Erie County in 1971 were 139 MGD. (2-209) Assuming negligible increase for 1969 to 1971 in Ashtabula and also Erie County (there were no new industrial movements), the total reported power and cooling water use for the two counties was estimated to be 582 MGD in 1970. No data exist for Crawford County; however, such withdrawals are believed small. For the Regional Study Area, the estimate is raised to 600 MGD. During the years 1970-1975, no new industrial development significantly increased power cooling withdrawals and therefore, 600 MGD for 1975 in the Regional Study Area should be a reasonable estimate. Within the Principal Study Area, power cooling water use was 127 MGD in 1970, and is projected to total again 127 MGD in 1980 and 137 MGD in 1990. (2-211)

Baseline Projections

2.697
Baseline water-use projections are given in Table 2-390 for the years 1975, 1981, 1986, 1990. Following the rationale of the Withdrawal Uses subsection, baseline population projections, and estimated total water use unit requirements of Table 2-386 an overall estimate of the quantities of water to be withdrawn for domestic, public/commercial, and leakage uses is given (assuming constant total water use per capita per day). Agricultural water use projections, given in Table 2-382, are summarized in Table 2-395 for 1975, 1981, 1986, 1990. The estimates for 1981 and 1986 in Table 2-385 result from a linear interpolation between 1980 and 1990 values of Table 2-382. The same rationale for the 1981, 1986, and 1990 industrial water use baseline projections has been adopted.

c) Transport Uses

2.698
Sewage effluent from municipal sewage treatment plants and heat from cooling processes are the two major waste products that need to be transported from the Regional Study Area. Waste loads are produced by over 125 identifiable point source discharges.

d) In-Place Uses

2.699
Water-oriented recreation, flood control and navigation (also a transport water resources use) are the three principal in-place uses of water in the Regional Study Area. From a water standpoint, the two first uses are very different and almost reciprocal. Water-oriented recreation requires a rather steady preserve of water at the sites, whereas flood control requires space of empty capacity at the sites to accommodate water. Recreational water resource use is mostly measured in terms of facilities such as swimming pools, boat moorings, length of publicly owned major streams, water/land surface area, licenses, fees, attendance, and others. Flooding, a demand for storage space for volumes of water which exceed the carrying capacity of normal stream channels is closely related to many of the other water uses (e.g., reservoir for flood control, withdrawal, or recreation purposes).

Table 2-386

Natural Ponds in Ashtabula County

Location	Type	Acreage
Austinburg Township N. of Lampson Road	Wooded swamp	10
Austinburg Township Woodside Drive	Wooded swamp	3
Austinburg Township Tote & Switzer Roads	Shrub swamp	10
Geneva Township Geneva St. Park	Deep fresh marsh	35
Geneva Township North Avenue & Padanarum	Wooded swamp	5
Geneva Township Rt. 20 & Penn Central	Shrub swamp	5
Geneva Township Myers Road & Maple Ave. N. of Penn Central	Shrub swamp	3
Morgan Township River Dale Rd.-North	Shrub swamp & wooded swamp	Unknown
Morgan Township Fobes Rd.-North	Shrub swamp & wooded swamp	Unknown
Morgan Township Rice Road	Bog	Unknown
Orwell Township Windsor Rd. near RR tracks	Deep fresh marsh	Unknown
Plymouth Township Rt. 46 & Rt. 11	Deep fresh marsh	150
Plymouth Township Rte. 31--east of Ashtabula	Shrub swamp	5
Saybrook Township Penn Central Tracks and Nineveh Road	Shrub swamp	15

Name	Description
Shallow fresh marshes	Soil normally waterlogged during the growing season; often covered with as much as 6 inches of water. Usually holds water till July 1. One-forth acre on up.
Deep fresh marshes	Soil covered with 1/2 foot to 3 feet of water during the growing season. Sometimes goes dry in fall. Any size.
Open fresh water	Water of variable depth. Have water from year to year but may go dry in periods of drought. Most of these waters contain fish. One-fourth acre up.
Shrub swamps	Soils normally waterlogged during growing season. Often covered with as much as 6 inches of water. Button bush, alders, willows, etc. One fourth acre up.
Wooded swamps	Soils waterlogged to within a few inches of surface. Often covered with as much as 1 foot of water. Vegetation includes snapweed, boneset, spicebush, overatory red maple, elm, black ash, swamp white oak. Any size.
Bogs	Soils waterlogged, blanketed with mosses; also with heath shrubs, etc. Very few of these still in existence. One fourth acre up.

Source: Farm Pond Investigations, Crane Creek Wildlife Experiment Station, Division of Wildlife, Ohio Department of Natural Resources, 1973.

Biotic Environment

Terrestrial Environment

Regional Study Area

2.700
The Regional Study area as described earlier in this report (refer to Figure 2-132) encompasses Ashtabula County, Ohio and Erie and Crawford Counties, Pennsylvania. The region consists of a wide range of community types including forested areas, open areas, both cultivated and non-cultivated, wetland areas, and stream and lake areas. For the purposes of this discussion only, the common names of all plants and animals are used. The scientific names of the flora and fauna found within the Regional Study Area may be obtained by contacting the U.S. Army Engineer District, Buffalo, 1776 Niagara Street, Buffalo, New York 14207.

a) Ashtabula County

2.701
Much of Ashtabula's 422 million acres provides habitat for wildlife, primarily along the lake plain, ravines, and streams. (2-213) Over 30 percent of the country is wooded. (2-214) Streams include Conneaut Creek, Turkey Creek, and the Ashtabula and Grand Rivers, of which the first two are of primary interest to the project site. Only about seven percent, located mainly in the northern areas, of the land is used for residential, industrial, or commercial purposes.

Forest Areas

2.702
Forests in Ashtabula County generally consist of young timber stands limited to terrain either too wet or too rough for agriculture. As agricultural fields have been abandoned, timber stands have been allowed to grow providing increased wildlife habitat, especially for upland game and white-tailed deer. (2-215) These early successional stages of forest include hawthorne thickets with wild cherry, crab apple, sumac, aspen, and some oak and maple. (2-216) Products from the woodland are used to supplement incomes of farmers and part-time farmers as well as being used for recreational facilities such as camps, campgrounds and hunting areas. (2-214) The County lies in the north central forest region with beech, sugar maple, hemlock, yellow birch, and other associated species growing throughout. The beech-maple associated is predominant and species generally found mixed within these stands include white ash, red oak, white oak, basswood, black cherry, cucumbertree, and shagbark hickory. The oak-hickory and chestnut oak forests occur in the northwest part of

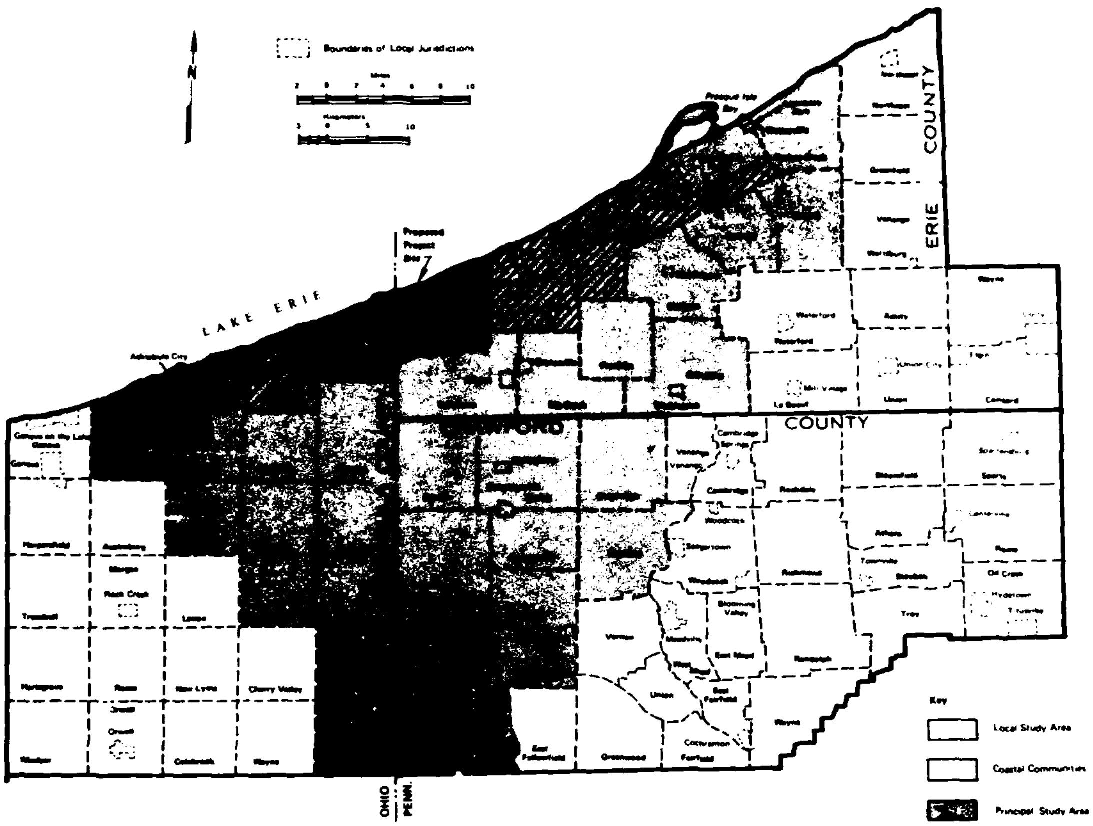


FIGURE 2–132 REGIONAL STUDY AREA

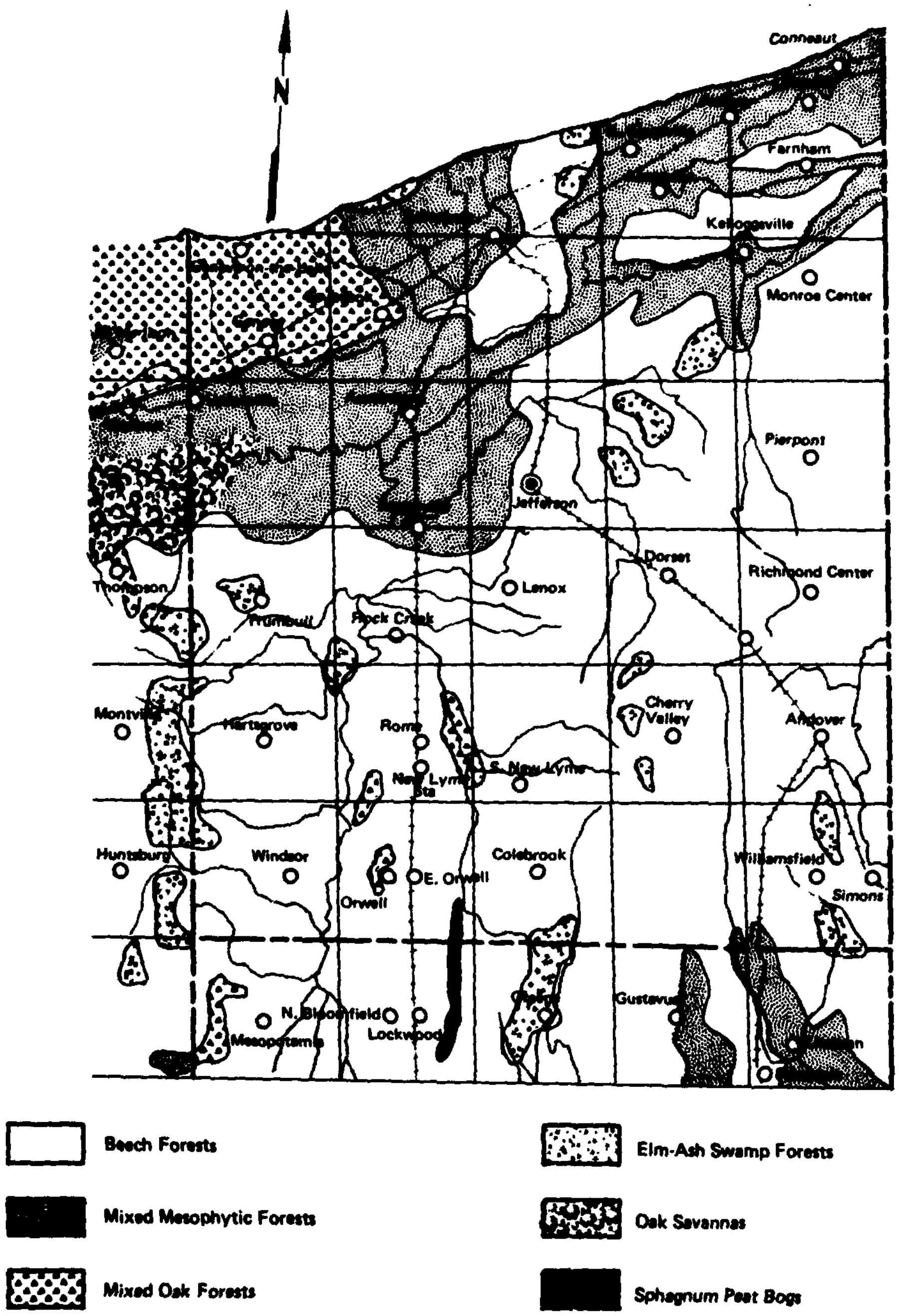
the county, on the well drained soil of the lake plain, and also along south-facing slopes and on hilltops. However, due to the virtual elimination of American chestnut, the black and white oak and hickory (shagbark, bitternut, pignut and mockernut hickories) remain as the dominant trees in these areas. Other trees associated with these species include red oak, scarlet oak, sour gum, flowering dogwood, sassafras, Virginia pine, pitch pine, and/or shortleaf yellow pine. Along the wetter areas of the lake plain and scattered throughout the county several swamp forests occur. These consist mainly of white elm, white ash, silver maple, and red maple, although in some areas the elm has been eliminated. On better drained lands, bur oak, shellbark hickory, and red oak-basswood are associated. Species found in both stands include pin oak, swamp white oak, white oak, black walnut and tulip tree. Areas contiguous with the swamp forests generally include "wet beech" forests, wet prairies, sedge swamps and ferns. (2-217) Along much of the lake plain, the predominant original forest was mixed mesophytic, dominated by broad-leaved and deciduous species, but with no single species prevailing. The mosaic of types include oak-chestnut-tuliptree, oak-hickory-tuliptree, white oak-beech-maple and hemlock-beech-chestnut-red oak associations. (2-217) The conifers in the county have largely been destroyed, although hemlock is still widely distributed along stream banks and on the lake plains, occurring with maple, hickory, beech and oak. (2-214) A map of the forest types of Ashtabula County is shown in Figure 2-133.

Open Areas

2.703
The majority of land in Ashtabula County at this time is open while some being used for agricultural purposes while the rest is idle. The trend has been towards a decline in agricultural land and an increase in other open or idle areas. In 1971, 47.4 percent of land in the County was devoted to agricultural purposes, while 45 percent was idle and open.

Undisturbed Open Areas

2.704
The undisturbed open areas are undergoing succession whereby one plant community is being replaced by another. As this transition proceeds, forest cover is replenished, timber is produced, and wildlife habitat value is improved. These open areas are scattered throughout the county, and are often situated adjacent to agricultural land. Except where fences or other barriers prevent wildlife movement, the open land provides wildlife pathways. These areas are particularly important when used as farm-game cooperatives, where farmland is managed for simultaneous use as game and wildlife



Source: "Natural Vegetation of Ohio," Robert B. Gordon, Ohio Biological Survey, 1966.

FIGURE 2–133 NATURAL VEGETATION OF ASHTABULA COUNTY AT THE TIME OF THE EARLIEST LAND SURVEYS

habitat. These open areas also provide feeding and breeding grounds for a variety of birds. Herbaceous upland plants associated with the open areas (principally idleland) include foxtail, ragweed, smartweed, panicgrass, wild oat, native bush-clover, and herbs. (2-214)

Cultivated Areas

2.705
The soils in Ashtabula County are generally low to moderate in agricultural productivity. However, through implementation of proper soil management techniques they are used extensively for agricultural purposes. In Ashtabula County the agricultural lands extend over most of the county with the exception of the developed areas along the lake shore. The main field crops are corn, soybeans, and small grains such as wheat and oats. Specialty crops such as grapes, fruit trees, vegetables, and nursery crops, are grown on an area of about 4,100 acres. These are most heavily concentrated in an area five to six miles wide bordering the southern shore of Lake Erie with the largest acreage being in Geneva and Harpersfield Township. These specialty crops are grown primarily near Lake Erie due to the climate moderating effects of this water body. Major specialty crops grown in this area include peaches, cherries, grapes, apples, peas, and vegetable crops. Nurseries are important along the sandy soils of the lake plain and beach ridges. A large area (400 acres in the east central part of the county) is used for potatoes. (2-214) Some of the less well managed or more eroded lands are used for pasture. Major pasture and hay plants here are alfalfa, Ladino, clover, red clover, timothy, birdsfoot trefoil, orchard grass, and bromegrass. Since dairying accounts for over half of the gross farm income of the county, much of the pasture is used by dairy cattle.

Wetland Areas

2.706
Except for seasonal wet areas, Ashtabula County has relatively few wetlands. Much of the land is poorly drained, and therefore water runs off toward Lake Erie rather than seeking permanent seepage. More extensive wetland areas occur in adjacent counties, i.e., Mentor Marsh in Lake County and Fern Lake in Geauga County. There are a number of bogs, marshes, and swamps in the Principal Study Area in Ashtabula County which are part of the Natural Areas Project in Ohio. Some of these are listed below (refer to Figure 3-63).

2.707
Armstrong Hemlock Grove

This site has a total surface area of 4-5 acres and is located 1,000 feet south of Daniels Avenue on old Route 7 in Conneaut. The bog

contains sphagnum, characteristic ferns and a clear stream. Mature hemlocks can be found along the northern and southern sides.

2.708
Buttonbush Swamp

Buttonbush Swamp is located on the south side of Ridge Road, east of Wetmore Road in Conneaut and covers a total of 24 acres. The site contains a buttonbush swamp, sphagnum bog, hemlock forest and several open ponds. Portions of the site contain old fields which are undergoing secondary succession. The area is used as a nature preserve and study area for Kent State University.

2.709
Pennline Bog

This site is situated on the State line, 2,000-3,000 feet north of Footville-Richmond (Thompson) Road in Richmond Township and consists of a bog, swamp, and marsh. Much of the area has been drained in the past for agricultural purposes. However, the land that is not being worked has or is in the process of reverting to its natural state.

2.710
Plymouth Marsh

Plymouth Marsh is located one mile south of I-90 in Plymouth Township. Although an extensive marsh most of it is now in pasture. At the end of of the open area is a 20-acre swamp forest, consisting of elm which appears to be suffering from Dutch Elm disease.

2.711
Pymatuning Beaver Ponds

The ponds are part of a preserve which is located within Andover Township. The site covers a total of 120 acres and contains mixed mesophytic and swamp forest associations.

2.712
Swamp Forest

The site is located southwest of the junction of Woodward Road and the State line in Richmond Township. Vegetation consists almost entirely of elm, with some sugar maple, large tooth aspen and oak. In addition, there are a number of natural marshes, bogs and farm ponds, recorded in a farm pond investigation conducted by the Ohio Department of Natural Resources (DNR). Some of the major ones are listed in Table 2-386. Many of these provide resting places for migratory waterfowl.

Riparian Habitats

2.713
Riparian or flood plain areas in Ashtabula County support fauna and flora which provide food and cover for a number of game and non-game species. Most of the major streams flood periodically, supplying sources of nutrients to the banks, where willows, cattails, marsh grasses, and other water-tolerant plants predominate. (2-214) Conneaut Creek, upstream from the proposed project site runs through hardwood forest in some areas and softwood in others. Three tracts adjacent to Conneaut Creek in Kingsville Township have been designated by the Ohio Department of Natural Resources for inclusion in a Natural Areas Project. According to the Ohio DNR, two of these tracts should be preserved. (2-218) Tract "A" includes a mile-wide strip across both sides of the creek, north of I-90 and south of South Ridge Road. The southern face of the ridge has a flood plain beechmaple forest and rich herbaceous flora. The north slope supports hemlock, striped maple, and black maple. Tract "B", located directly north across South Ridge Road, is a level ridge-top for 100 yards, followed by a steep north-facing slope and flood plain. The slope supports hemlock and northern tree species while the flood plain is rich in northern species. There is no pasturing and little cutting in these areas. Tract "C" is located north of South Ridge Road and consists of an old orchard, an old field and 10-15 acres of ridgetop woods. This area of beech-maple forest, with a 300-foot strip of pure hemlock, has had little unnatural disturbance since the 1920's. The rugged northfacing slope has original stable roundleaf dogwood and striped maple vegetation. (2-218)

2.714
Another site designated for inclusion in the Natural Areas Project is located in Kingsville Township on the north side of Fox Road between Route 84 and the Township line which extends north to Conneaut Creek. This area contains flood plains with yellow birch and hemlock, a beaver dam, and much juneberry. The rolling upland area, which has been cut over the years, is presented occupied by a beechmaple forest. It supports wildlife populations of beaver, fox, squirrel, muskrat, mink, deer, and raccoon. A great blue heron rookery is located along the creek, east of Route 6. (2-219) Most of the creek's banks provide good grouse habitat. Woodcock habitat is found further away from the water.

2.715
The Grand River also provides a variety of flood plain wildlife habitats. The riparian forest still contains many of tree species in the beech and elm-ash-swamp maple associations, although the vegetation is now probably characterized by a predominance of elm-ash-swamp maple, followed by maplebirch and oak-hickory. (2-220) Additional

successional stages are represented by aspen, dogwood, and hawthorne. The present forest cover consists of a strip of varying width (300 feet to 1 mile) on either side of the river, extending most of its length. Native white pine and hemlock are common in the steep gorge downstream from Harpersfield to a point east of Painesville. In general, very little of the Grand River Valley basin is urbanized. As a result, the existing cropland, forests and pastures provide numerous and varied wildlife habitats. Forty-nine species of mammals, 154 species of birds, 21 species of reptiles, and 24 species of amphibians are known to occur in the basin. A complete list of these species is contained in the reference "The Grand River Reservoir Project: Impact on Wildlife," Grand River Committee, Ohio Chapter of the Wildlife Society (August, 1971). The basin supports a major forest game range in northeastern Ohio, supporting deer, ruffed grouse and woodcock, as well as nesting and migrant waterfowl, particularly wood duck. (2-221)

Lake Shoreline

2.716
The shoreline of Lake Erie consists primarily of sand and other coarse materials washed up from the lake. They are generally narrow and separated from inland areas by a fairly steep escarpment which is frequently subject to severe erosion. (2-214) With low moisture capacity, these areas are not suitable for support of significant vegetative growth, and except as resting places for waterfowl and other birds, they do not support large wildlife populations.

Wildlife of Ashtabula County

2.717
A variety of wildlife habitats are abundant in the county because it is relatively undeveloped and has vegetative cover and food supply, both cultivated and noncultivated. In the Conneaut area, grouse habitat is reported "very good" (2-222) and woodcock habitat is "excellent". Ashtabula County is one of the top two counties in Ohio for migratory bird and waterfowl hunting. However, quail populations are reported to be low and pheasant populations only mediocre. The pheasant population is occasionally supplemented through stocking by the Conneaut Fish and Game Club. No beaver were recorded in Conneaut on a 1976 colony survey. Historically, most beaver colonies in Conneaut City have been associated with Conneaut Creek; the last known one (1975) was west of Farnham Bridge (Center Road) and near the city line. The beaver harvest for all of Ashtabula County has declined to 159 in 1977 from 259 in 1974, the highest harvest in the last 17 years. (2-222) Waterfowl hunting occurs along the Conneaut Harbor U. S. East Breakwater and also along the Lake Erie shoreline

in the vicinity of the mouth of Turkey Creek. Shore hunting was more prevalent before the current period of high lake levels cutback most of the shoreline to its present steepness." (2-222) Deer gun kill in Conneaut and Ashtabula County has been reported as shown in Table 2-387. A list of the game species hunted in Ashtabula County, their populations and harvest counts is presented in Table 2-388. Ashtabula County has a number of farm cooperative agreements, where farmers grant hunters permission to use their lands. There are 12,317 acres available for such use (79 agreements) in the county and 185 acres (one agreement) in Conneaut. (2-222) Farm game includes cottontail rabbit, red fox, squirrel, mourning dove, and pheasant. Principal games species taken in the county include ruffed grouse, turkey, white-tailed deer, and grey squirrel woodcock, a popular game bird with restricted habitat requirements, is being threatened by drainage of wetlands and destruction of inundated woodland stands. Ashtabula County is reported to have more birds than any other county in Ohio. Approximately 295 species have been identified in the Ashtabula County area based on records compiled by Mr. & Mrs. J.P. Perkins, Conneaut, Mr. & Mrs. Howard Meahl, Ashtabula, Sam Wharram Nature Club, and data from several publications. The list, which is too lengthy to reproduce here can be obtained from the U. S. Army Engineer District, Buffalo. (2-223)

2.718
The presence of such a large number and diversity of birds in Ashtabula County and also in Erie County, Pennsylvania, may be partly attributed to the proximity of the area to major U.S. flyways as well as the availability of a wide variety of food and cover. Major waterfowl flyways extend from further south (and include the Pymatuning Reservoir) to the southern shore of Lake Erie, where the birds move east or west along the shore and along the land masses into Canada. Migration paths of other birds have been charted by Mr. J. P. Perkins, who found 17 flyways over the Great Lakes, from Duluth on Lake Superior to Conneaut on Lake Erie. The "Central" flyway, identified by Mr. Perkins, includes the Presque Isle Peninsula near Erie, Pennsylvania, and hosts some 20 species of birds. (2-224)

Summary of Unique Biotic Features

2.719
There are several sites within the county that can be considered high quality habitat in terms of available food and cover. Several of these areas have been described previously. However, there are 19 other areas in the county designated as unique under the Natural Areas Project. Each of these sites is described below.

Table 2-387

Deer Gun Kill in Conneaut and Ashtabula County

Season	Conneaut Kill	County Kill	% of County
1976	34	372	9
1974	22	264	8
1973	26	215	12
3 yr. Total	82	851	9.6

Source: Wildlife Comments and Harvest Records received from Clyde Simmerer, District Wildlife Supervisor, Ashtabula County, Ohio, June 1977.

Table 2-388

Game Populations in Ashtabula County

		Game seen per 1000 R.M.C.(Rural Mail Corner) Survey Miles	
		Spring	Summer
1970	Rabbit	2.3	5.1
	Pheasant	1.0	2.3
	Quail	0.0	0.0
1971	Rabbit	1.8	4.8
	Pheasant	1.8	1.9
	Quail	0.0	0.0
1972	Rabbit	2.4	8.7
	Pheasant	1.8	2.2
	Quail	1.5	0.0
1973	Rabbit	3.4	5.5
	Pheasant	1.3	0.6
	Quail	0.0	0.1
1974	Rabbit	2.6	14.8
	Pheasant	3.1	2.4
	Quail	0.1	1.4
1975	Rabbit	2.7	11.4
	Pheasant	1.8	0.6
	Quail	0.0	0.4
1976	Rabbit	6.7	8.7
	Pheasant	2.2	1.7
	Quail	0.1	0.0
1977	Rabbit	5.7	--
	Pheasant	3.3	--
	Quail	0.0	--

Game Harvest in Ashtabula County per 100 Gun Hours

1976 Bag Checks:

Rabbit	41.0
Pheasant	6.6
Quail	--
Dove	163.0
Squirrel	9.1
Teal	4.8
Waterfowl	115.6

Table 2-388 (Continued)

	Non-Harvest Kill	Legal Harvest
1970	116	159
1971	149	222
1972	147	222
1973	145	221
1974	147	270
1975	193	315
1976	138	376

Source: Ashtabula County Game Statistics, Ohio Department of Natural Resources, Division of Wildlife, May 1977.

2.720
Warner's Hollow. This area is located in Phelps Creek Gorge, Windsor Township. It is a deep east-west gorge with Canadian zone plant life and especially excellent habitat for newts and salamanders.

2.721
Thoburn Property. This area is located in Orwell Township and is a private sanctuary of old farm and second-growth forest on level clay.

2.722
Pymatuning State Park. The park covers 4,886 acres and contains a variety of wildlife habitat.

2.723
New Lyme Wildlife Area. This is a protected wildlife preserve located in South New Lyme which occupies a total area of 530 acres.

2.724
Vort Woods. This woodland is situated in Windsor Township and covers a total area of 50 acres. Predominant species include beech and maple and to a lesser extent tulip, linden, yellow birch, and top hornbeam. The herbaceous flora is rich in species and diversity. Timber has not been harvested from the site since 1900 and there has been no pasturing. The site exhibits rolling terrain, contains a stream and is a good example of a stable beech-maple forest type.

2.725
Hubbard Pine Woods. This woodland is located in Conneaut at Gore Road and extends southward to U.S. 20. It is situated on a sand plain with predominant species consisting of white pine and hemlock. Although the site is in poor condition, the Ohio DNR recommended that the site be protected so that existing stands could regenerate.

2.726
Great Blue Heron Rookery. (Ashtabula Rookery) This rookery is located in Richmond Township, between Route 7 and Pymatuning Lake Road, and contains about 100 nesting sites which are situated in a mature beech forest.

2.727
Fillingham Road Woods. Located in the southeast corner of Rome Township this site is a flat, second growth forest situated on a clay floor. Typical species include elm, maple, linden, oak, and a variety of spring flora. (2-252)

2.728
Beaumont Scout Reservation. This site consists of offers 1,200 acres of relatively undisturbed habitat in the vicinity of Rock Creek.

b) Erie and Crawford Counties

2.729
Erie and Crawford Counties are quite similar to Ashtabula County in land use and habitat type. Also predominantly agricultural, they support a diverse wildlife population. However, the Pennsylvania counties generally contain more extensive wetland habitats.

Forest Areas

2.730
Soil Conservation Service data indicated that 189,777 acres of Erie County were forest in 1967. The predominant, natural vegetation in Erie County is a beechsugar maple/red maple hardwood forest, while secondary species include white elm, white or black ash, red maple, birch chestnut oak, northeastern conifers and oak hickory, with some pines and hemlocks. As in Ashtabula County, most of the original vegetation has been removed (2-225), and secondary forest growth is present. In the coastal region of Erie County approximately 23 percent of the land is wooded with the greatest density of woodlands occurring in the western portion of the county bordering Lake Erie. The central portion of the Erie County coastal area is primarily residential, commercial, and industrial, while the eastern section is becoming more agricultural. (2-226) The predominant tree species are alder, ash, aspen, locust, red maple, red oak, sassafras, sycamore, and willow. Also present in the central and western areas are beech, hemlock, and wild cherry. Walnut is found along the eastern portion. (2-226) In Crawford County, some 465.5 square miles of land (somewhat less than half of the total land area) is forested. Reforestation is rapidly increasing due to a decline in farming. Although woods are scattered throughout Erie County, the most heavily wooded area lies in the eastern half. (2-227) There has been little or no vegetative mapping done in the Pennsylvania counties, as a result, less information is available on forest resources than for Ashtabula County, Ohio.

Open Areas

2.731
Most of the land in Erie and Crawford counties at the present time is open, either idle or used for agriculture. The trend has been toward an increase in open or idle land for example, in Erie County during 1954, 61 percent of the land was in forest, a decrease from earlier years. (2-225) During 1970, 87 percent of the land in Crawford County was is in agriculture, while eight percent was classified as open land. (2-227)

Undisturbed Open Areas

2.732
As with Ashtabula County the undisturbed open areas contain a wide variety of food and cover plants which ultimately lead to a more diversified wildlife population. These areas are scattered throughout the two-county area, often adjacent to agricultural land or woodland.

Cultivated Areas

2.733
In Erie County the most productive agricultural areas are those in the lake plain which are used for many specialty crops. The upland areas further south in Erie and Crawford Counties are used more for dairy farming. In Crawford County, agricultural land has been on a long-term decline, due to expansion of urban uses, conversion of farm dwelling to non-farm occupancy and increase in forest acreage. (2-228)

2.734
Horticultural products are also important. Production of trees, shrubs, vines and ornamental plants as well as cut flowers, potted plants, florist greens and bedding plants have provided some eight percent of farm income in Erie County. Pertinent statistics on the agricultural industry in Erie County have been provided by the United States and Pennsylvania Department of Agriculture and the Erie County Cooperative Extension. These data are shown in Tables 2-389 and 2-390, respectively. Erie County is an important agricultural area with about 16 percent of the land area of the forestal communities in cultivation. Most agricultural pursuits are confined to the temperate lake plain where the moderating effects of Lake Erie result in a longer growing season. However, livestock and dairy farming occurs in the upland areas to the south of the lake. In addition, cabbage and cauliflower are grown as cash crops in the uplands along with potatoes which are generally produced in soils formed by the outwash of the inland valleys. Early maturing fruits and vegetables such as grapes, sour cherries, applies, tomatoes, and asparagus are grown in the temperate plain, with most orchards and vineyards occupying a five to six-mile strip along the lakefront northeast of the city of Erie.

2.735
Grape production ranks first in Erie County with Concord the leading variety, while sour cherries rank second. Other fruit crops of importance include cherries, peaches, apples, plums, prunes, and pears. Although field crops are of lesser importance in terms of total product they are nevertheless significant sources of income.

b) Erie and Crawford Counties

2.729
Erie and Crawford Counties are quite similar to Ashtabula County in land use and habitat type. Also predominantly agricultural, they support a diverse wildlife population. However, the Pennsylvania counties generally contain more extensive wetland habitats.

Forest Areas

2.730
Soil Conservation Service data indicated that 189,777 acres of Erie County were forest in 1967. The predominant, natural vegetation in Erie County is a beechsugar maple/red maple hardwood forest, while secondary species include white elm, white or black ash, red maple, birch chestnut oak, northeastern conifers and oak hickory, with some pines and hemlocks. As in Ashtabula County, most of the original vegetation has been removed (2-225), and secondary forest growth is present. In the coastal region of Erie County approximately 23 percent of the land is wooded with the greatest density of woodlands occurring in the western portion of the county bordering Lake Erie. The central portion of the Erie County coastal area is primarily residential, commercial, and industrial, while the eastern section is becoming more agricultural. (2-226) The predominant tree species are alder, ash, aspen, locust, red maple, red oak, sassafras, sycamore, and willow. Also present in the central and western areas are beech, hemlock, and wild cherry. Walnut is found along the eastern portion. (2-226) In Crawford County, some 465.5 square miles of land (somewhat less than half of the total land area) is forested. Reforestation is rapidly increasing due to a decline in farming. Although woods are scattered throughout Erie County, the most heavily wooded area lies in the eastern half. (2-227) There has been little or no vegetative mapping done in the Pennsylvania counties, as a result, less information is available on forest resources than for Ashtabula County, Ohio.

Open Areas

2.731
Most of the land in Erie and Crawford counties at the present time is open, either idle or used for agriculture. The trend has been toward an increase in open or idle land for example, in Erie County during 1954, 61 percent of the land was in forest, a decrease from earlier years. (2-225) During 1970, 87 percent of the land in Crawford County was is in agriculture, while eight percent was classified as open land. (2-227)

Table 2-389

1967 Fruit Tree and Grapevine Summary and 1975 Crop and Livestock Summary in Erie and Crawford Counties

Fruit	Number of Orchards/Vineyards		Total Trees/Vines		Total Acres as % of State	
	Erie Co.	Crawford Co.	Erie Co.	Crawford Co.	Erie Co.	Crawford Co.
Apples	94	2	52,164	1,450	2.7%	0.12%
Peaches	103	--	38,144	--	2.3	--
Pears	89	1	13,848	N/A	11.8	N/A
Sour Cherries	92	--	58,587	--	20.3	--
Sweet Cherries	89	--	11,655	--	40.0	--
Grapes	337	1	5,355,783	N/A	99.0	N/A
Nectarines	6	--	194	--	1.1	--
Plums, Prunes	62	--	11,505	--	16.5	--
Total	353	2			16.6	1.0

Crops	Acres Harvested		Production as % of State	
	Erie Co.	Crawford Co.	Erie Co.	Crawford Co.
Wheat	3,600	4,100	1.1%	1.2%
Oats	11,000	15,700	2.9	4.0
Barley	300	700	0.2	0.3
Corn (Grain)	13,200	14,800	1.2	1.4
Corn (Silage)	9,700	14,600	2.1	2.9
Alfalfa	10,300	12,800	1.0	1.2
All Hay	47,000	45,000	2.2	2.0
Potatoes	2,700	490	9.5	1.6

Table 2-389 (Continued)

Livestock	Head		% of State	
	Erie Co.	Crawford Co.	Erie Co.	Crawford Co.
Milk Cows	14,600	22,900	2.1%	3.2%
Hogs & Pigs	2,100	2,700	0.3	0.4
Cattle & Calves	41,600	54,600	2.1	2.8
Sheep & Lambs	800	2,400	0.7	2.0

Source: Pennsylvania Fruit Tree and Grapevines Survey, Pennsylvania Department of Agriculture, Pennsylvania Crop Reporting Service, 1967; 1975 *Crop and Livestock Annual Summary*, Pennsylvania Department of Agriculture, Pennsylvania Crop Reporting Service and U.S. Department of Agriculture; Arthur D. Little, Inc. estimates.

Table 2-390

The Agricultural Industry in Erie County

Farm Production in Erie County

Inventory or Activity	Value ($)
Number of Commercial Farms	1,048
Capital Investment on All Farms (value of land, buildings, machinery, and livestock)	$178,391,000
Average Capital Investment per Farm	$ 142,000
Annual Cash Receipts from Sale of All Farm Products	$ 44,000,000
Milk	$ 15,000,000
Fruit	12,000,000
Potatoes and Vegetables	5,000,000
Livestock Products	3,000,000
Forest and ornamental Crops	4,000,000
Field Crops	4,000,000
Poultry Products	1,000,000
Total	$ 44,000,000

(ranks 7th among counties in Pennsylvania)

Farm Business Purchases in Erie County

Some of those goods and services are:

	Value
Labor and Machine Hire	$ 5 million
Feed	4,500,000
Fertilizer	2 million
Petroleum Products	1,500,000
Seeds and Plants	1 million
Lime and Chemicals	1 million
Total Annual Purchase of Goods and Services by Commercial Farms	$ 27,000,000

TABLE 2-390 (Continued)

Food Processing in Erie County

Number of Processors	41
Number of Employees	2,074
Wages and Salaries	$ 15,000,000
Value of Products	$ 156,000,000

Source: Erie County Cooperative Extension, 850 East Gore Road, Erie, PA 16509

Note: Table does not include all Farm business costs.

Such crops include corn, oats, wheat, buckwheat and rye. Feed crops are also important food sources for the dairying and livestock operations. These include hay, clover, grasses, and alfalfa. Livestock and livestock products account for 48 percent of farm income in the county. Principal livestock and associated products are dairy cattle, with milk and butter fat products, chickens and eggs, and sheep and wool. These are all located primarily in the southern part of Erie County and in Crawford County. Many of the farm areas in Erie and Crawford Counties are useful for game and nongame species. Some of the abandoned dairy farms are stocked with species such as pheasant while several others are used as game farms. (2-253)

Wetland Areas

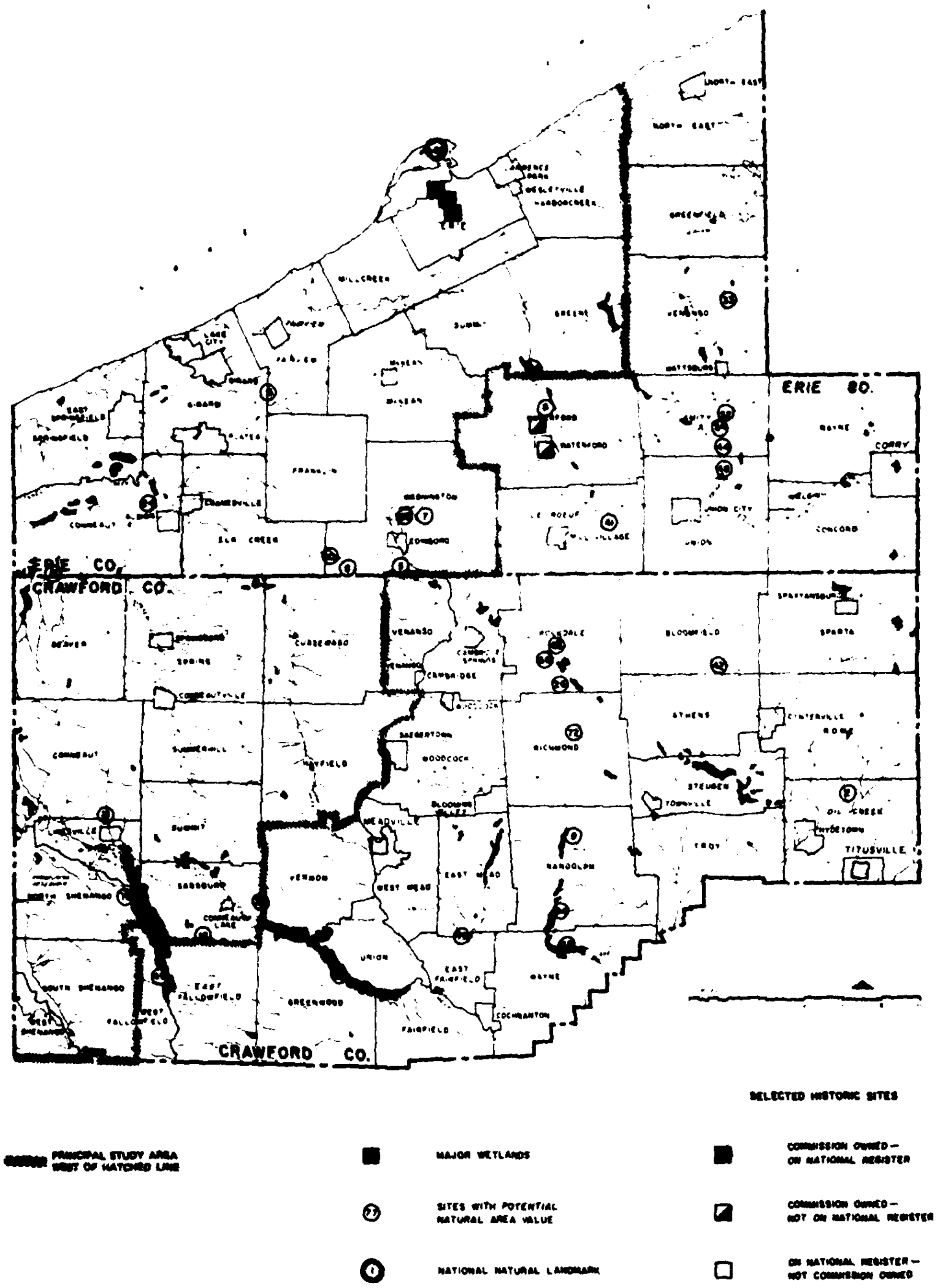
2.736
Both Erie and Crawford Counties contain a number of wetland areas (swamps, bogs and marshes) and of these over 20 have been identified as potential candidates for inclusion in a statewide system of natural areas. (2-263) Significant wetland areas within the Pennsylvania portion of the Principal Study Area are shown in Figure 2-134. Wetlands located within the Coastal Communities are described as follows:

Area 1 — Presque Isle State Park, Erie; (3,100 acres). Presque Isle, a seven-mile long recurved sandspit in Lake Erie, is a famous example of primary xeric succession on sand. All stages of succession are present up to mature oak forest. Cottonwood communities of various ages are most common. There are a variety of marsh communities making this one of the most important wetlands in the State. It is also an important migratory point for many land birds. Presque Isle is a National Natural Land mark.

Area 15 — Devil's Backbone, Erie; (100 acres). An unusual erosion landscape where Elk Creek has cut a deep meander creating a narrow point of land only a few feet wide. Area is reported to contain a virgin stand of beech-sugar maple.

Area 24 — Conneaut Creek Herron Rookery, Erie; (20 acres). Reported small rookery on the swampy flood plain of Conneaut Creek.

Area 17 — Jumbo Woods, Erie and Crawford. This woodland consists of a mature stand of beech-sugar maple located on State Game Lands, and within the confines of a large great blue heron rookery. The area is diverse, with old fields, grass-sedge wet meadows, successional forests, and maturing second growth forest. (2-219)



Original Source: U.S. Geological Survey Quadrangle Maps.
Preliminary *List of Natural Areas* in Pennsylvania by the Western Pennsylvania Conservancy (1974).
Pennsylvania's Recreation Plan, 1976, Office of State Planning and Development.
As Located In: Northwest Area Profile, A Baseline for the Future Commonwealth of Pennsylvania.

FIGURE 2–134 ENVIRONMENTALLY SENSITIVE AREAS IN ERIE AND CRAWFORD COUNTIES

2.737
Most of the wetlands in the Regional Study Area are located in the Allegheny and Beaver River sub-basins of the Ohio River drainage although at least one large wetland is located in the Lake Erie drainage basin. Two large wetland tracts exist within the Principal Study Area namely those associated with Presque Ise (Lake Erie drainage) and Pymatuning Reservoir (Ohio River drainage). Both of these wetlands are important since they provide habitat for waterfowl. The Atlantic flyway, one of the principal migratory routes for avifauna, traverses the Regional Study Area in the vicinity of both Presque Isle and the Pymatuning Reservoir. As such these wetlands serve an important function as resting, feeding, and nesting areas for a variety of birdlife especially waterfowl. An example of waterfowl usage at the Pymatuning Reservoir is shown in Table 2-391.

2.738
The land mammals and birds taking sanctuary in wetlands include many game species such as pheasant, showshoe rabbit, deer, raccoon, woodcock and ruffed grouse. The swamp darter (a member of the perch family), the bog turtle and the swamp rattler are rare or endangered fish or reptiles dependent on wetland habitat. In addition, there may be other endangered or rare salamanders, frogs, lizards, and toads native to Pennsylvania that live in isolated wetland sites. Some endangered bird species use thse wetlands during migration and for nesting. For example, Eskimo Curlews used to rest in Erie County during migration, but have not been sighted in recent years. (2-229) Wetlands also may provide habitat for rare or endangered plant species. There are a number of wildflowers, (orchid and lily types) which are rare or endangered, along with certain sedges, grasses, rushes, phlox and weeds. These species may be uncommon locally or throughout the State of Pennsylvania. Wetlands In central Crawford County have been preserved as wildlife habitat by the Bureau of Sport Fisheries and Wildlife, U.S. Department of Interior. Although these areas have been set aside for management purposes, they are opened for public hunting of game species on a seasonal basis. The Game Commission operates a 4,000-acre goose management area adjacent to the Pymantuning Reservoir (Pymatuning Waterfowl Area). This facility is used to encourage the propogation of geese as well as other migratory waterfowl. Controlled shooting of waterfowl is permitted in State-operated management areas. (2-229)

Riparian Habitats

2.739
That portion of Conneaut Creek located in Pennsylvania was designated a wilderness area at one time because of the availability of high quality habitat for deer grouse, woodcock, beaver, muskrat, fox, squirrel, mink, and raccoon. In addition, the creek supports a large

Table 2-391

Annual Waterfowl Records -- Pymatuning

Whistling Swans	
Using Route	40 - 50,000
Canadian Geese	
Peak Spring Population	20,000
Banded, per year	300
Nesting and Summering Population	3,000
Taken by Hunters	2,500
Ducks	
Using Route	40 - 50,000
Banded, per year	10,000
Total Number of Nesting Species	100+
Acres Under Agricultural Cultivation	2,200

Source: Personal Communication, Ray Sickles, Pymatuning Water Fowl Agent, April 1977; "The Pymatuning Story", Nick Sisley, Reprinted from Pennsylvania Game News, Pennsylvania Game Commission.

herron rookery in a flood plain area near Route 6. The variety of wildlife habitat contained along the course of this creek is probably due to the gentle sloping nature of the banks and the availability of flood plain sites. Other creeks such as Trout Run, Mill Creek, Fourmile Creek, and Sixteenmile Creek have steeper banks and less variability in habitat types. Raccoon Creek, which runs along the eastern edge of the proposed site, offers less terrestrial habitat than Conneaut Creek except in the bottomland (on and near the site) where grouse habitat is good. Upstream the adjacent land is used primarily for farming or pasture.

2.740
Both Erie and Crawford counties contain a wide variety of habitat which is reflected in the diversity and abundance of birdlife. In addition, the location of a migratory flyway in both counties also contributes to the richness of species with 300 or more sited during 1976. A checklist of birds recorded for Erie County, Pennsylvania, has been developed, but is too lengthy to reproduce here. Those interested in obtaining a copy should contact the U.S. Army Engineer District located in Buffalo, New York. The average annual population, harvest and hunting data for the cottontail rabbits, gray squirrels, white-tailed deer, ring-necked pheasants, and ruffled grouse in the two counties and the Northwest Division (10-county totals) is presented in Table 2-392. These game populations support a very active hunting interest in the two-county area as evidenced by the recent harvest estimates for the major game species shown in Table 2-393. There are 33,500 acres of State Game Lands in the two counties, including heron rookeries and a pheasant holding pen. Within the State gameland system approximately 1,600 acres are maintained under cultivation. Cooperative game farmlands which are stocked and operated by the Pennsylvania Game Commission consists of 12,000 acres. One area (#73) located in Springfield Township, includes an 18-acre wildlife refuge.

Biotic Features in Erie-Crawford Counties

2.741
Like Ashtabula County, Erie and Crawford Counties offer somewhat unique wildlife habitat because of their combination of agricultural, open, and wooded lands, Many of the remaining rural areas support large populations of wildlife. Areas of special biotic interest are Presque Isle Park and Pymatuning Reservoir. Presque Isle is an important area ecologically, for it contains a transition from beach to climax forest within a three-mile area. (2-226) In addition, its labyrinth of marshes, ponds, and lagoons provide scenic beauty and protected habitat for resident or migrant species. Pymatuning Reservoir, although not a natural area, has been managed for wildlife, especially waterfowl. At present, the area offers food and resting or breeding places to thousands of migrating and resident birds in addition to habitat for deer, squirrel, rabbit, pheasant, and grouse.

Table 2-392

Average Annual Population, Harvest, and Hunting Data for Crawford and Erie Counties

	Range Type	Acres Habitat	Harvest '72-'73 Avg.	Harvest Rate (%)	Harvest Per Acre	Value Harvest Per Acre	Fall Population Per Acre	Yearly Population Per Acre	Hunting Effort Man-Days/Acre
Cottontail Rabbits									
Crawford		479,926	58,194	15%	0.121	$ 2.99	0.808	3.555	0.205
Erie		399,373	63,629	15%	0.159	3.92	1.062	4.673	0.209
Northwest Div. Totals		2,484,902	499,752	-	0.201	4.96	-	-	-
Gray Squirrels									
Crawford		298,900	23,123	10%	0.077	$ 0.56	0.774	1.160	0.165
Erie		189,777	13,771	10%	0.073	0.53	0.726	1.088	0.128
Northwest Div. Totals		2,401,131	252,868	10%	0.105	0.76	1.049	1.573	-
White-Tailed Deer									
Crawford		617,420	1,749	20%	0.0028	$ 2.79	0.0142	0.0177	0.083
Erie		469,590	980	20%	0.0021	2.09	0.0104	0.0130	0.062
Northwest Div. Totals		3,888,050	22,367	-	0.0058	5.72	-	-	0.171
Ring-Necked Pheasants									
Crawford	2nd Class	207,607	4,015	35%	0.019	$ 0.40	0.055	0.083	0.179
	3rd Class	346,442	4,177	35%	0.012	0.26	0.034	0.052	
Erie	1st Class	3,332	172	35%	0.052	1.11	0.148	0.221	0.174
	2nd Class	201,607	4,547	35%	0.023	0.48	0.065	0.096	
	3rd Class	277,530	3,861	35%	0.014	0.30	0.060	0.060	
Northwest Div. Totals	-	2,706,377	-	-	-	-	-	-	-
Ruffed Grouse									
Crawford		298,900	7,845	15%	0.026	$ 0.24	0.175	0.263	0.174
Erie		189,777	6,994	15%	0.037	0.34	0.246	0.369	0.169
Northwest Div. Totals		2,401,131	63,306	15%	0.026	0.24	0.176	0.264	-

1st Class - Good natural population; needs no stocking; best habitat: wheat & alfalfa cover; little woodland.

2nd Class - Natural reproduction does occur but the bird population is limited & could not be maintained without restocking. Habitat is not as good as first class; might be more oats & timothy grown.

3rd Class - All "put & take" hunting; almost no natural reproduction. Habitat included very little wheat or alfalfa grown; the amount of woodland is greater than in other classes. Many third class areas support dairy farms.

Source: Wildlife and Game Data received from John Kriz and Hugh Palmer, Game Biologists, Pennsylvania Game Commission, Feb. 1978 & June 1977.

Table 2-393

Harvest of Game Species in Erie and Crawford Counties

	Erie	Crawford	Season
Rabbits	95,166	64,087	1975-76
Grouse	6,265	7,771	1975-76
Ringneck Pheasant	13,317	13,217	1975-76
Squirrels	15,521	27,754	1975-76
Doves	25,930	5,646	1975-76
Antlered Deer	601	992	1976
Antlerless Deer	659	1,010	1976

Source: Pennsylvania Game Commission estimates.

c) Anticipated Future Biotic Trends in the Regional Study Area

2.742
Under baseline conditions development in the residential, commercial, and industrial sectors is expected to reduce the amount of available woodland and openland habitat. Agricultural lands along lake include grape vineyards and orchards may be reduced as development pressure increases. In addition, lands currently used for commercial timber production or pasturage may be displaced depending on their economic value relative to other uses. In general, as the amount of farm and open land diminishes, so does the amount of habitat which supports and attracts wildlife. Pressure brought about by hunters and other recreationalists may cause some lands to remain suitable for wildlife, if they are preserved as open space and recreation areas. Pymatuning Wildlife Management Area is one such example. Beyond the disruption of habitat and community displacement which may occur as a result of development, there may be other influences associated with changing land use patterns. Specifically, increasing commecial, residential, and industrial activity would contribute to the burden of atmospheric contaminants which may have adverse effects on biotic communities of the region. The set of atmospheric contaminants normally associated with urban and technologic activity include the following:

a) oxides of sulfur and nitrogen;
b) oxidants (ozone and peroxacyl nitrates);
c) hydrocarbons; and
d) particulates.

Other compounds, such as hydrogen fluoride, may be associated with specific sources and hence, may constitute a potential hazard only for those species which have proximity to the source. To anticipate future biotic trends in the Regional Study Area, it is important to be aware of the effects of these compounds on vegetation and animal life, including livestock, wildlife, and humans.

The Proposed Lakefront Plant Site

2.743
The biotic characteristics of the proposed plant site were determined through the performance of field studies during the period between March 1977 and November 1977. All field work was performed by Aquatic Ecology Associates (AEA), Pittsburgh, PA, under the direction of the applicant and the interagency technical team. The principal features of the terrestrial biota as presented in this section have been obtained from various AEA reports prepared during the sampling period. Species lists and other tables have not been included in this statement to conserve space; however, they are on file with the U. S. Army Corps of Engineers, Buffalo District.

2.744
During the survey cruises conducted by AEA, three vegetative types, trees, shrubs, and herbs were broken down into nine vegetative cover types. This information is presented in Figure 2-136. Representative study areas were located within each major cover type so that quantitative sampling of the vegetation could be accomplished. In addition to the floristic analyses, data were collected on insects and related invertebrates, reptiles and amphibians, avifauna, and mammals. This sampling effort originally began within each designated vegetation study area, but was later expanded to include nearly all of the plant site. The location of the nine terrestrial study areas and a list of the vegetative associations and principal species encountered within each is presented in Figure 2-135 and Tables 2-394 and 2-395, respectively. A generalized vegetation map of the Lakefront Plant site is shown in Figure 2-136 while the environmentally sensitive areas and wetlands are delineated in Figures 2-137 and 2-138.

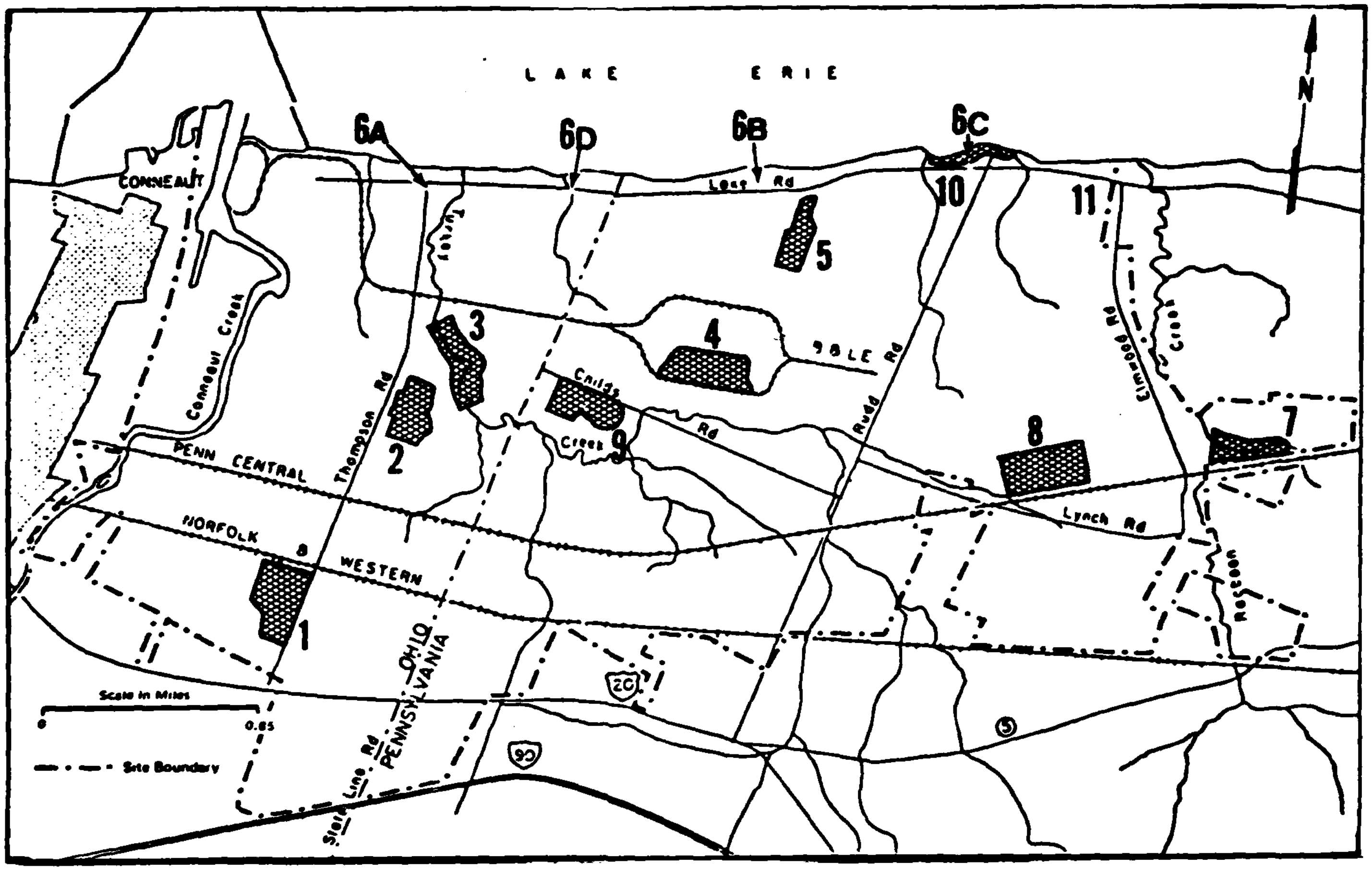
Flora of the Lakefront Site and Usage by Wildlife

a) Forested Areas

2.745
In general, all of the forest communities within the proposed lakefront plant site have been disturbed at one time or another. As a result, succession is proceeding at varying rates producing stands of trees ranging from young immature saplings dominated by red maple to near climax communities. Although most of the woodlands have been selectively cut some still contain trees with a diameter greater than three feet.

2.746
Two areas in the eastern portion of the plant site are relatively well-drained and as such support a hemlock-hardwood forest which is probably most indicative of original forest conditions. Both woodland sites are dominated by hemlock, sugar maple, yellow birch, and American beech. Other species present in the canopy include red maple, white oak, red oak, hickory, tuliptree, and black cherry. Typical shrubs found in both stands consist of stipped maple, maple-leaved viburnum, hazelnut, and spice bush while ground cover consists mostly of Christmas fern, wood fern, cinnamon fern, false lily of the valley, violets, and club mosses.

2.747
Wet forests of both deciduous and coniferous-deciduous vegetation are found in several areas of the proposed site. The largest stands are located in the eastern section west of Elmwood Road while smaller



Source: Aquatic Ecology Associates (Appendix E).

FIGURE 2–135 LOCATION MAP OF THE NINE TERRESTRIAL BIOTIC COMMUNITY STUDY AREAS AND SUPPLEMENTARY AREAS (Revised September 1, 1977)

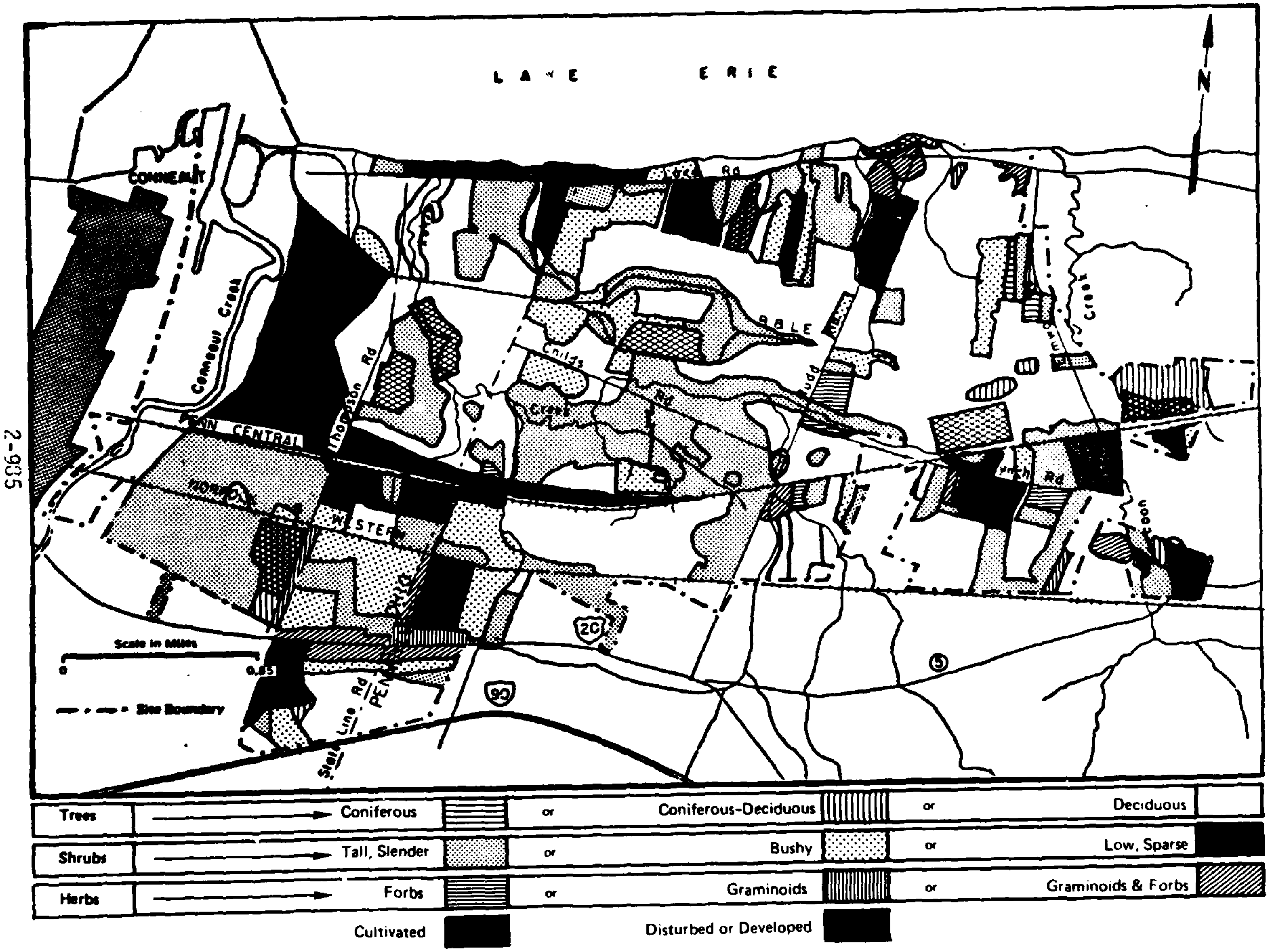
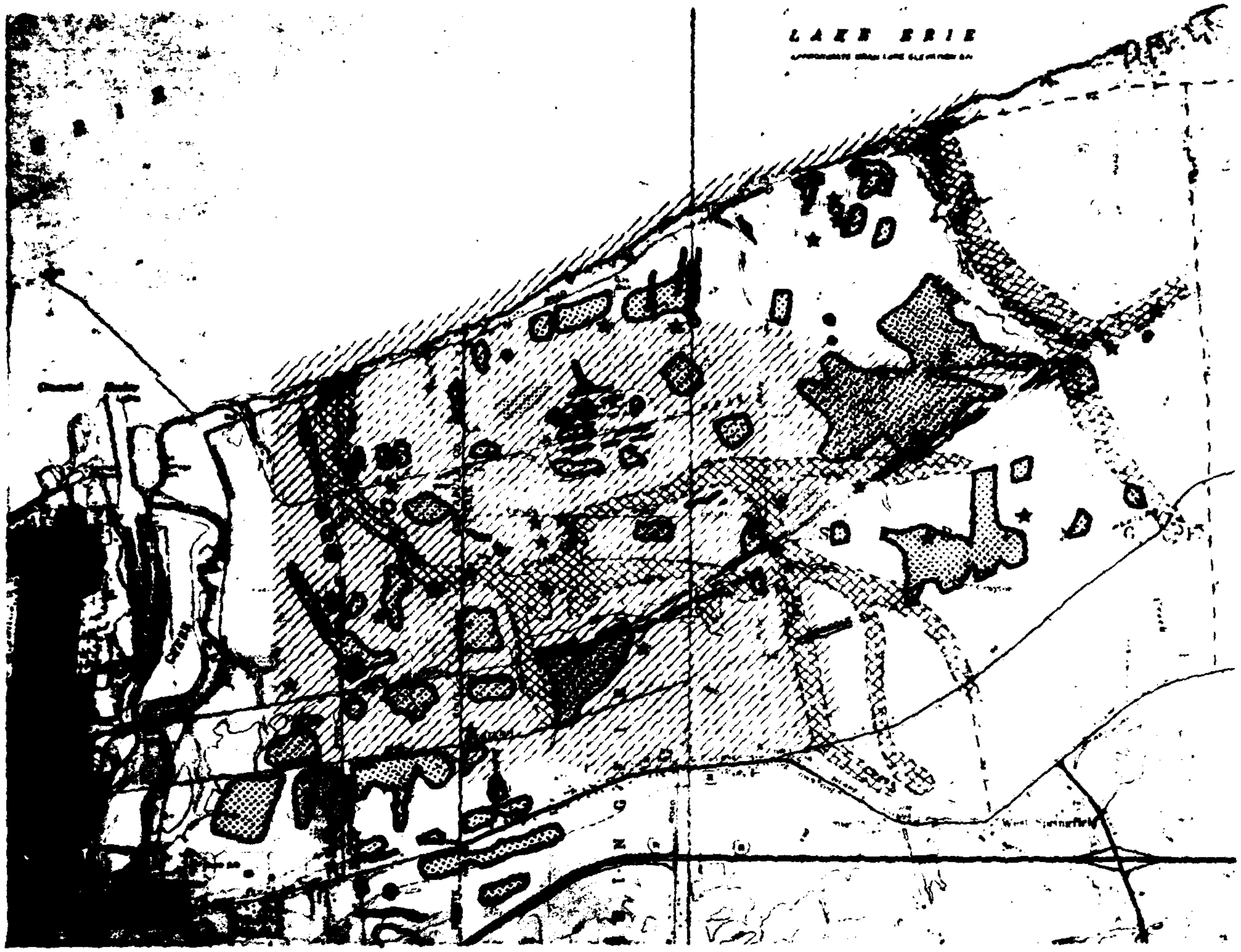


FIGURE 2-136 VEGETATION TYPES OF THE LAKEFRONT SITE



Source: Aquatic Ecology Associates (see Appendix E)., Arthur D. Little, Inc.

LEGEND:

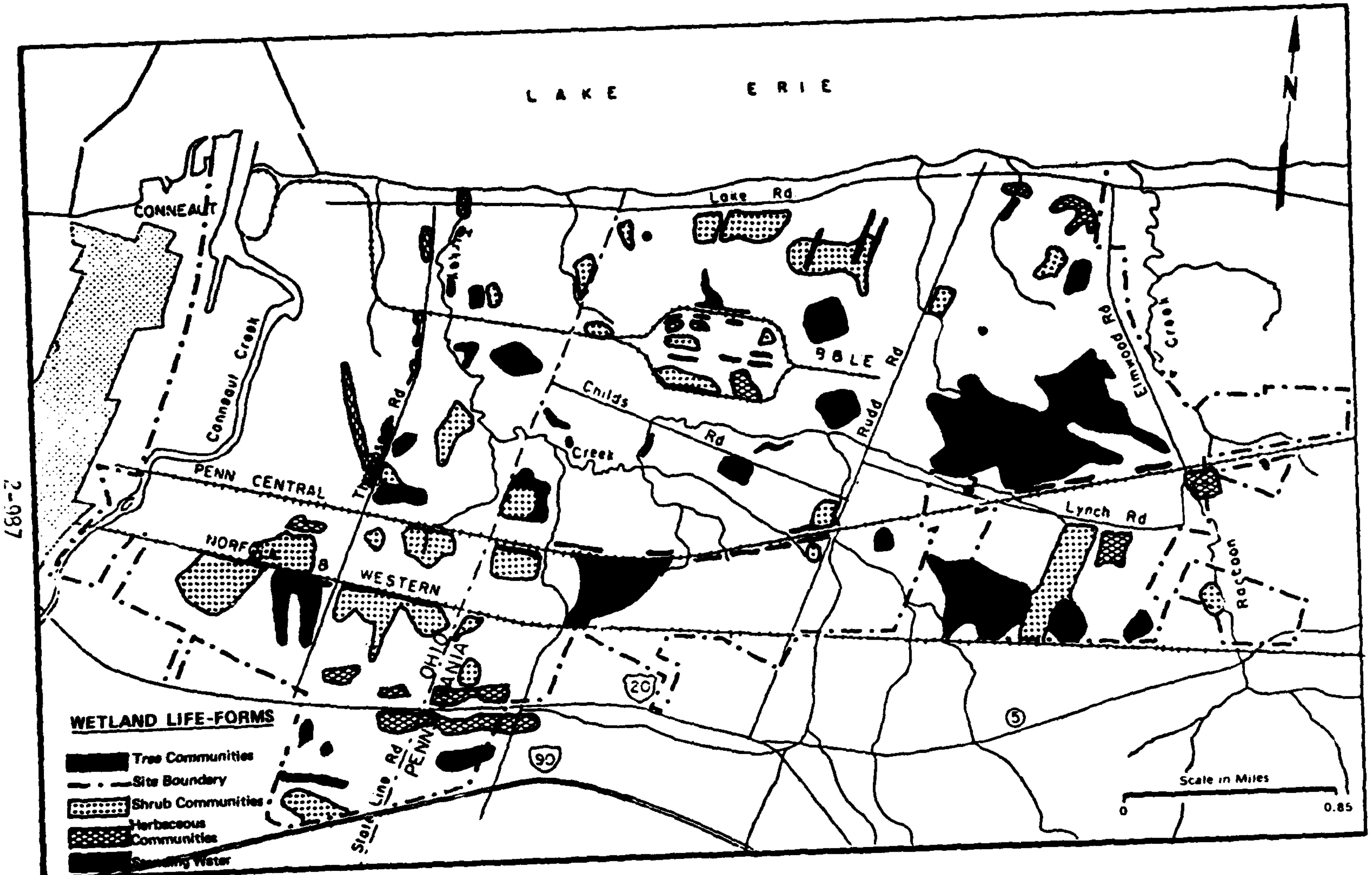
- Rare or Unusual Plants
- Floodplain

Wetlands:

- Standing Water
- Emergent Vegetation
- Wet, Woody Communities
- Important Mammal Habitat
- Important Game Bird Habitat

SCALE 1:24000

FIGURE 2–137 SENSITIVE BIOLOGICAL RESOURCES ON THE PROPOSED PLANT SITE



Source: Aquatic Ecology Associates (See Appendix E.)

FIGURE 2–138 WETLAND COMMUNITIES BASED ON LIFE-FORMS FOUND ON THE PROPOSED LAKEFRONT PLANT SITE

Table 2-394

Community Study Site Characteristics at the Proposed Lakefront Plant Site

Study Site No.	Vegetative Community Description
1	Disturbed hemlock-hardwood community
2	Late stage, old field succession dominated by red maple
3	Stable flood plain, sugar maple community with abundant spring flower community
4	Intermediate old field, grass-goldenrod-wild carrot
5	Early old field stage, mixture of grasses and forbs
6	Beach area
7	Hemlock-hardwood, relatively undisturbed
8	Swamp forest community
9	Intermediate mixed shrub community

Source: Aquatic Ecology Associates.

Table 2-395

Biotic Communities and Vegetation Types Found at the Proposed Lakefront Plant Site

Coniferous forest:
- White pine
- White pine-pitch pine
- White pine-scotch pine

(1) (7) **Coniferous-deciduous forest:**
- Hemlock-hardwood
- White pine-red maple
- White pine-sugar maple

(3) (8) **Deciduous forest:**
- Beech-sugar maple
- Mixed hardwoods
- Osage orange
- Quaking aspen
- Quaking aspen-red maple
- Red maple
- Red maple-American elm
- Red maple-hardwood
- Red maple-swamp white oak
- Red oak-hickory
- Red oak-hickory-basswood
- Sour gum-black cherry
- Sugar maple
- Swamp white oak
- Willow

(2) **Tall slender shrubs:**
- Alder
- Black locust-staghorn sumac
- Fire cherry-quaking aspen
- Hawthorn-crabapple
- Mixed shrubs
- Quaking aspen
- Red maple
- Red maple-black cherry
- Red maple-hardwoods
- Red maple-quaking aspen
- Red maple-sour gum

(2) **Tall slender shrubs:**
- Silky dogwood
- Sour gum
- Sour gum-staghorn sumac

(9) **Bushy shrubs:**
- Hawthorn-crabapple
- Hawthorn-silky dogwood
- Mixed shrubs
- Quaking aspen
- Red maple
- Red maple-sour gum
- Silky dogwood

Low sparse shrubs:
- Mixed shrubs
- Quaking aspen-silky dogwood
- Silky dogwood
- Arrowwood-silky dogwood

Forbs:
- Goldenrod-aster-wild carrot-dewberry
- Blackberry-goldenrod

Graminoids:
- Mixed grasses
- Sedge-rush
- Sedge-rush-cattail

(4) (5) **Graminoids and forbs:**
- Cattail-skink cabbage-sedge-grassmarsh marigold
- Grass-rush-sedge-goldenrod-wild carrot
- Grass-goldenrod-dewberry-sheep sorrel-blackberry
- Mixed grasses-mixed herbs

○ Indicates a study site where examples of this vegetation are found, but not the only location on the proposed project site.

Source: Aquatic Ecology Associates, Inc., Summary Report, July 1977.

stands are typically found in the southwest and central portions of the site. Red maple is usually dominant in the deciduous stands while both red maple and hemlock may be dominant in the coniferous-deciduous stands. Other sub-dominants characteristic of these wet forest associations are yellow birch, sour gum, swamp white oak, and several species of ash. Ferns which are representative of these wet areas consist mainly of royal fern, sensitive fern, and cinnamon fern which typical shrubs include spice bush, witch hazel, and winterberry holly. Occasionally, Sphagnum sp. is found in the wetter portions of the site.

2.748
Since a large proportion of the site is in secondary forest growth, study areas were established to provide more definitive information on the deciduous and hemlock-hardwood stands. The results of these vegetation studies are presented below:

Study Area 1

Vegetation Type: Coniferous-deciduous forest
Community Type: Hemlock-hardwoods
Successional Status: Subclimax
Dominants: Red maple, American beech, hemlock, swamp white oak, yellow birch
Subdominants: Red oak, white ash, hop hornbeam, black cherry, tulip tree, sugar maple
Ground Cover: False-lily-of-the-valley, sensitive fern, touch-me-not, flexous spear-grass, Canadian violet

The hemlock-hardwoods are concentrated in the south central portion of the study area and are generally less distinct toward the extreme northern and southern sections. Within this area large individual specimens of hemlock, American beech, and yellow birch are typical. Spring flora included several species of violets, wild geranium, trout lily, large flowered trillium, and spring beauty. The percentage of flowering plants in the total ground cover decreased as the canopy closed while woody plants and some composites increased. Late summer ground cover included false lily of the valley, partridgeberry, sarsaparilla, and many ferns. One of the few stands of skunk cabbage found on the lakefront site lies at the southern end of this study area. Study Site 1 is basically a small subclimax forest tract surrounded by various other plant communities. The mixture of habitats creates an edge effect which attracts both forest and forest edge species. Bird species generally found in this study area include the robin, song sparrow, woodthrush, catbird, house wren, and flicker. Nesting species observed at this location include the red-eyed vireo, white-breasted nuthatch, hooded warbler, yellow bellied sapsucker, veery, and scarlet tanager. The wet nature of the forest

floor in this area is demonstrated by the presence of the Acadian flycatcher and ovenbird. Mammals observed or trapped within this area include the short-tailed shrew, eastern chipmunk, meadow jumping mouse, and mink.

2.749

Vegetation Type: Deciduous trees
Community Type: Sugar Maple
Successional Status: Subclimax
Dominants: Sugar Maple
Subdominants: Basswood, yellow birch, red oak, black cherry, hop horn beam, American beech, tulip-tree
Ground Cover: Wild garlic, violets, jack-in-the-pulpit, Carolina spring beauty, sugar maple

Sugar maple is the dominant tree in the canopy, subcanopy, shrub, and ground cover strata and apparently the dominance of this species is the result of past logging operations. In addition the subdominants listed above, black walnut was also found in the vicinity of Turkey Creek and two butternut trees were recorded at the north end of the study area. Prevernal ground cover at this location was quite abundant, consisting of wild garlic, Carolina spring beauty, two-leaved toothwort, cut-leaved toothwort, violets, large-flowered trillium, bloodroot, wild ginger, Virginia spring beauty, Solomons seal, false Solomons seal, false hellebore, New York fern, sensitive fern, shield fern, and cinnamon fern. This study area is devoid of conifers and includes the ravine (valley) through which Turkey Creek flows. Birds occupying this area include the Acadian fly catcher, belted Kingfisher, northern water thrush and woodduck as well as the ovenbird and red-eyed vireo. Mammals captured in this area include the short-tailed shrew, white-footed mouse, meadow jumping mouse, and a single flying squirrel. Other mammals either observed or noted through other forms of physical evidence are the fox squirrel, red fox, raccoon, and striped skunk.

b) Open Areas

2.750
A number of open areas can be found within the proposed site boundaries which are in various stages of succession and date from 10 to 60 years in age. These range from recently cultivated fields and vineyards, which still show signs ot disturbance, to early and late stage fields. Activities accounting for this disturbed condition include farming, raw materials storage and logging. Cultivated areas are primarily located in the eastern and southeastern portions of the site, along Lynch and Rudd Roads. These include small fields of corn, cabbage and squash and small vineyards. The largest disturbed

open area is on the banks of Conneaut Creek and eastward beyond Thompson Road. The field communities have been classified as low sparse shrubs, bushy shrubs, and tall slender shrubs. A description of the vegetation and fauna of each study area within this classification is presented below:

Study Area 5

Vegetation Type: Graminoids and forbs
Community Type: Grass-forbs
Successional Status: Old Field
Dominants: Mixed grasses, fragrant goldenrod, sheep sorrel, blackberry, dewberry, cinquefoil
Subdominants: Common horsetail, bindweed, red clover, self-heal, wild carrot, common rush

The site is dominated by a mixture of grasses and forbs and appears to have been abandoned about five years ago. Dewberry and blackberry are recent invaders and are very abundant in the eastern and southern portions of this study area. A few shrubs consisting mostly of staghorn sumac and silky dogwood are invading the area, but most of these are scattered and not very abundant. Spring flowers were few in number and were limited to cinquefoil, sheep sorrel, and the chick weeds. However, summer flowers were found to be abundant and a large number of asters and goldenrods bloomed during the late summer and fall. Numerous water-filled depressions that support stands of common rush can be found throughout the area. In general, the site provides suitable habitat for a variety of mammals and avifauna, although, herpetofauna were found to be relatively scarce. Mammals collected or observed at this location include the masked shrew hairy tailed mole, white-footed mouse, meadow vole, meadow jumping mouse, chipmunk, rabbit, and woodchuck. Avifauna expected to be present or actually sighted during field investigations are the bobolink, meadowlark, eastern kingbird, sparrows (including the savannah sparrow, grasssparrow, songsparrow, and field sparrow), marshhawk, and kestrel. Herpetofauna collected in this study area include the American toad, garter snake, and spotted salamander (occupation based on the prevalence of egg masses).

2.751
Study Area 4

Vegetation Type: Graminoids-forbs
Community Type: Grass-goldenrod-wild carrot
Successional Status: Intermediate old field community
Dominants: Meadow grass, goldenrod, reed grass, wild carrot, reed canary grass
Subdominants: Red clover, yellow harkweed, self-heal, strawberry, dandelion, ox-eye daisy, dewberry

This area is dominated by a mixture of forbs and graminoids although woody plants such as the speckled alder, willow, cottonwood, and quaking aspen are invading the area. Ditches and wet depressions contain rushes, sedges, water-tolerant grasses, and some duckweed. Other areas exhibiting soil moisture content somewhat less than saturation support dense stands of reed canary grass although this species is generally scattered throughout. The drier portions of the site generally support forbs and meadow grasses. As in Study Area 5, the variability of habitat along with adequate food and cover make this area suitable for a number of wildlife species. The area is used as a foraging site by swallows and as a nesting area by certain species of snipe. In addition to these avian species, woodcock, swamp sparrow, song sparrow, killdeer, bobolinks, and loggerhead shrikes were also observed. Mammalian usage of the area is also high with such species as the masked shrew, short-tailed shrew, meadow vole, and meadow jumping mouse collected during this site investigation. Other mammals noted to be present either through direct observation or through habitat preference analysis include muskrat, red fox, racoon, striped skunk, deer, bats, least weasel, and possibly the southern bog lemming. This area exhibited the greatest diversity of herpetofauna probably because of the number of semi-permanent ditches and seasonal ponds. Species collected include the spotted salamander (egg masses), red spotted newt, red backed salamander, spring peeper, gray tree frog, leopard frog, wood frog, green frog, bullfrog, brown snake, northern water snake, eastern garter snake, stinkpot turtle, and spotted turtle.

2.752
Study Area 9

Vegetation Type: Bushy shrubs
Community Type: Mixed shrubs
Successional Status: Intermediate shrub community
Dominants: Red maple, silky dogwood, crabapple, hawthorn
Subdominants: American elm, white ash, arrowwood, sour gum, black cherry, apple
Ground Cover: Fragrant goldenrod, tall hairy goldenrod, blackberry, ground cedar, strawberry, dewberry, haircup moss, running ground pine.

Study Area 9 is a bushy shrub community which is an intermediate stage between the successional stages of Study Area 5 and Study Area 2 and it is estimated to have been disturbed about 25 years ago. This type of community was chosen for detailed analysis because it is representative of large sections of the Lakefront Plant site. Silky dogwood is present in the greatest numbers although there is evidence that the area is being invaded by cottonwoods. Goldenrod and blackberry were the most abundant ground cover plants while the eastern

portion of the site consisted almost entirely of blackberry. No prevernal flowering plants were observed and spring flora was also scarse, consisting mostly of cinquefoil, strawberry, and yellow hawkweed. Wet depressions scattered throughout the site support populations of common rush. The habitat contained within this study area is especially suitable for large and small mammals and avifauna. Mammalian species collected during the sampling period include the masked shrew, meadow vole, and meadow jumping mouse. The site also appears to offer suitable habitat for white-tailed deer. Avifauna occupying this area include such species as the yellowthroat, song sparrow, field sparrow, and goldfinch, all of which are forest edge species. Sections of the study site containing dense shrub stands were utilized by such species as the robin, catbird, rufous-sided towhee, white-eyed vireo, and Traill's flycatcher. The pole stage aspen found minimally in this area were inhabitated by the downy woodpecker, red-eyed vireo, woodthrush, and veery. Field observations also indicate that blue-winged warblers nested in great abundance in this community type.

2.753
Study Area 2

Vegetation Type: Tall slender shrubs
Community Type: Mixed shrubs
Successional Status: Late shrub community
Dominants: Red maple, sour gum, silky dogwood
Subdominants: Black cherry, arrowwood, crabapple, hawthorn, white ash, quaking aspen
Ground Cover: Ground cedar, haricap moss, goldenrods, cinquefoil, strawberry, asters, dewberry

The general successional trend exhibited by the flora in this area is toward an early forest stage similar to the woodlands stands north of the Perry Bluff ore storage area. The shrubs that comprise this community can be separated into three groups: silky dogwood, arrowwood, black chokeberry; saplings of red maple, quaking aspen, and mature hawthorne and crabapple trees. In addition to the 12 species of woody plants recorded in the sampling transects, large-toothed and quaking aspen and black chokeberry were also observed on site. Staghorn sumac is found in a few isolated locations but clones of these shrubs are beginning to die off and invasion by red maple or other woody plants was found to be typical. No prevernal flowering plants were encountered and vernal species such as cinquefoil, strawberry, chickweed, mouse-ear chickweed, and sheep sorrel were generally scarce. Scattered grasses, goldenrods and aster remain from the former old field community. Gentian was observed in this area during October and the only specimens of ebony spleenwort found in the entire Lakefront Plant Site were collected here. Usage of

this study site by avifauna was more intense than in the earlier successional stages due to the mix of forest and forest edge plant species. Forest edge avian species encountered most frequently include the yellow warbler, catbird, song sparrow, yellowthroat and flicker while forest species were generally represented by the wood thrush, veery, red-eyed vireo, hooded warbler, American redstart, wood pewee, and ovenbird. The study area also supports a small nesting population of blue-winged warblers. Mammals either collected or observed at this location include the masked shrew, white-footed mouse, meadow vole, and the meadow jumping mouse. Evidence of occupation by red squirrel and white-tailed deer was also noted in this area.

c) Wetland Communities

2.754
There are very few permanent wetlands on the site although during the spring or periods of heavy rainfall the site does contain wet marsh-like areas. Permanent standing water is generally restricted to the drainage ditches adjacent to the railroad lines traversing the site (the former Perry Bluff ore storage area) several on site farm ponds, and several beaver dams on Turkey Creek. The location of the permanent standing water areas and on site wetland communities is shown in Figure 2-138. The majority of the larger wetland areas are situated toward the eastern and southern portions of the Lakefront Plant site. The existence of these wetlands, whether permanent or temporary, is due to the silty and clayey soils of the lake plain which are slowly permeable to water. Characteristic wetland forest trees include red and silver maple, American elm, red ash, willow, swamp white oak, sycamore and hemlock. Shrubs occupying Lakefront Plant site wetlands generally include speckled alder, willow, silky dogwood, buttonbush, arrowwood, and meadowsweet, while typical emergents consist of cattail, reed grass, rushes, sedges, and marsh marigold.

2.755
A seasonal wetland at the intersection of Crayton Road and the N&W Railroad contains a considerable amount of aspen ranging in diameter from 4-18 inches dBH. This site is apparently in a transitional state and may dry up as succession proceeds. During April 1977 this area provided habitat for grouse and a resting place for mallards. Another wetland just south of the Lakefront Plant site boundary in the vicinity of the N&W railroad tracks has standing water and contains buttonbush and cattail. The habitat value of this site is somewhat higher than seasonal wet areas which tend to dry up during the summer months.

2.756
To better characterize the seasonally wet areas on the Lakefront Plant site a study area was established in the swamp forest of the Turkey Creek watershed west of Elmwood Road and north of the Conrail tracks. The pertinent characteristics of this study site are defined below:

<u>Study area 8</u>

Vegetation Type: Deciduous forest
Community Type: Red maple-hardwood
Successional Status: Young deciduous forest
Dominants: Red maple, sour gum, white ash
Subdominants: Black cherry, tulip-tree, American elm, ironwood, sycamore, swamp white oak
Ground Cover: Ground cedar, spicebush, sensitive fern, New York fern, hay scented fern

This red maple-hardwood community was found to be wet throughout most of the spring of 1977 with standing water up to six inches deep persisting in some areas through the middle of June. The study area itself is very flat and shows little topographic relief. Portions are criss-crossed by furrows which are indicative of former agricultural use. The close proximity of a hemlock-hardwood community to the north suggests that this may have been the prominent community prior to disturbances. However, none of the species typical of such a community were found in this study area. Although most of the trees at this location are relatively small (5-25 cm dBH) one large red maple tree was recorded which is larger than the existing Pennsylvania "big tree" record. Vernal flora were observed only on hummocks above the wet depressions with ground cedar, spicebush, and violet most typical. Ferns often occupied the wet depressions in this study area. New York fern, hay scented fern, and sensitive fern were the most common.

2.757
At Study Area 8 also at Study Area 3, the representation of characteristic deciduous forest community birds reaches its best development. Avifauna utilizing this site include grouse, woodcock, blackbirds, the red-eyed vireo, eastern oven-bird, robin, American redstart, blackthroated green warbler, and the Eastern hermit thrush. The only nest belonging to a red-tailed hawk within the Lakefront site was observed at this location. Mammals collected in this study area or observed directly or indirectly include the white-footed mouse, chipmunk, red squirrel, fox, raccoon, and deer. Herpetefauna collected at this site consist of the wood frog, green frog and red-backed salamander.

d) Riparian (Flood Plain) Vegetation

2.758
Within the proposed Lakefront site riparian habitat is generally encountered along the course of Turkey Creek and in the vicinity of Raccoon Creek and Conneaut Creek near the eastern and western site perimeter, respectively. There are three distinct flood plain communities in the Turkey Creek watershed. The first consists of a disturbed forest between Lake Erie and the Bessemer and Lake Erie railroad tracks. The second flood plain community extending from the B&LE tracks to the State line is more stable and is best characterized as a mixed mesophytic stand. Canopy species found on the flood plain include sugar maple, hop hornbeam, basswood, tuliptree, red oak, and American beech. The third community consists of mixed shrub species and generally occupies the remainder of the Turkey Creek watershed within the proposed project site. Dominant vegetation consists of alder, hawthorn, and crabapple. In general, the riparian habitat of Turkey Creek supports such mammals as the meadow jumping mouse, shorttailed shrew, white-footed mouse, chipmunk, squirrel, woodchuck, rabbit, skunk, raccoon, and deer. Water snakes, wood frogs, toads, and salamanders (including one Jefferson salamander) were the principal herpetefauna species found along Turkey Creek.

2.759
The Raccoon Creek ravine north of the Conrail tracks has steep, well-drained slopes, and generally offers less diversified habitat for wildlife than does Turkey Creek. Portions of the ravine have been extensively logged for beach and maple although the woodlands near the Conrail tracks exhibit less disturbance. Ground flora along this watercourse generally exhibits diversification and abundance greater than any other area investigated. On the other hand, riparian habitat adjacent to Conneaut Creek near the western site boundary has been extensively disturbed and is of little value to wildlife. To characterize the riparian and woodland habitat adjoining Raccoon Creek a study site was established in the area immediately north of the Conrail tracks. A summary of the data collected at this site is presented below. Information on the riparian habitat of Turkey Creek is contained in the Study Area No. 3 discussion presented earlier in this section.

Study Area 7

Vegetation Type: Coniferous-deciduous forest
Community Type: Hemlock-hardwoods
Successional Status: Subclimax
Dominants: Sugar maple, white ash, hemlock, black cherry

Subdominants: Bitternut, red maple, yellow birch, hop hornbeam, witch hazel, American beech, basswood, tulip-tree
Ground Cover: Zigzag goldenrod, foam flower, enchanter's nightshade, false-lily-of-the-valley, mayapple, Carolina spring beauty, large-flowered trillium, squirrel corn, cut-leaved toothwort, New York fern, violets, Christmas fern, touch-me-not

Study Area 7 occupies the hillsides adjoining either side of Raccoon Creek. The area is relatively well-drained and supports a stand of near-climax hemlock-hardwoods. In addition, the sedges, wet grasses and water tolerant trees associated with the conifers and deciduous stands of Study Site 1 are noticeably absent. Sugar maple is the most abundant canopy species while witch hazel and maplé-leaved viburnum are the important understory species. American beech and hemlock occur in lesser numbers on the well-drained hillsides but tend to be dominant in the flood plain areas where the moisture content is relatively higher. The greatest concentration of mature hemlock occurs at the confluence of the east and west branches of Raccoon Creek. In general, this study area exhibits the most abundant and diverse ground cover of any community observed within the proposed Lakefront site. Prevernal and vernal flora encountered during the 1977 site investigation include mayapple, squirrel corn, wake robin, wild ginger, bloodroot, twoleaved and cut-leaved toothwort, bulbous cress, purple cress, trout lily, Indian cucumber root, Solomon's seal, false Solomon's seal, Jack-in-the-Pulpit, large-flowered trillium, false hellebore, wild phlox, sharp-lobed hepatica, partridge berry, wide-leaved ladies' tresses, foam flower, smoother sweet cicely, sweet white violet, Canada violet, smooth yellow violet, and round-leaved violet. The relatively large stand of squirrel corn encountered at this site is of significance since it has been proposed as an endangered plant in the state of Ohio. Summer flora observed in this study area includes zigzag goldenrod, foam flower, enchanter's nightshade, and false lily-of-the-valley. Pteriodophytes were also prevalent with 13 species of fern, one species of equisetum and four species of club moss noted.

2.760
As stated earlier the study area consists of a ravine adjoining Raccoon Creek which supports a hemlock-hardwood stand. This condition accounts for the prevalence of forest avifauna species rather than forest edge species. Some of the birds observed nesting at this location include the red-eyed vireo, eastern cardinal, hooded warbler, eastern overbird, wood thrush, Acadian flycatcher, American redstart, scarlet tanager, common flicker, eastern wood pewee, American robin, veery, eastern crow, red-breasted nuthatch, gray catbird, northern barred owl, eastern blackcapped chickadee, ruffed grouse, and northern pileated woodpecker. The variability of habitat

in the ravine environment influences the location of certain avi-fauna. For example, woodduck and water thrush nested in the vicinity of Raccoon Creek while the ovenbird was found to prefer the mesic ravine slopes. The maturity of the woodlands in this study area probably contribute to the increased number of pileated woodpecker sightings as compared to other areas. Mammalian occupation of the site was also studied. Species collected, observed, or noted to be present through the examination of tracks and fecal material include the shorttailed shrew, hairy-tailed mole, white-footed mouse, woodland jumping mouse, chipmunk, red squirrel, woodchuck, fox squirrel, red fox, raccoon, and striped skunk. The pileated woodpecker and woodland jumping mouse were observed only at this site.

e) The Lakefront

2.761
Although the lake shoreline and bluffs are steep and heavily eroded this area does support a wide variety of migratory and permanent waterfowl species. Large numbers of mergansers, buffleheads, goldeneyes, gulls, coots, kingfishers, loons, and grebes either feed or rest in the vicinity of the lakefront. Apparently the availability of open water, an adequate food source, and the proximity of migratory flyways contributes to this condition.

2.762
The Great Lakes in general represents a major obstacle to migratory birds. In the case of Lake Erie, spring migrants approach from the south often resting and feeding along the lakeshore prior to traversing this waterbody. Some species of waterfowl and passerine birdlife are reluctant to traverse the open lake and often seek the narrowest crossing point as an alternative to circumventing the obstacle altogether. On Lake Erie two such crossing points have been well documented. These include the route across the Bass Islands to Point Pelee in the western basin and the Presque Isle to Long Point route at the boundary between the central and eastern lake basins. Still other species such as the raptors will not cross the lake under most circumstances and tend to follow the shoreline around the lake. The location of the Presque Isle-Long Point lake crossing close to the Lakefront Plant site coupled with the attractive open water areas of the Pymatuning Reservoir to the south probably accounts for the large number of birds observed during the spring and fall migration periods. The breakwaters protecting the entrance to Conneaut Harbor probably account for the fact that many more birds were observed at Study Area 6A, as compared to 6B or 6C (refer to Figure 2-137).

2.763
The shoreline of the lake in the vicinity of the proposed project site consists almost entirely of a narrow beach up to 40 feet in

width that extends to the base of a nearly vertical bluff ranging in elevation from 5 to 50 feet. A permanent vegetative community does not exist in the beach area. However, the continual mass wasting of the lake bluff causes whole sections of bluff to be deposited on the beach as colluvium with its vegetation largely intact. Typical species inhabitating the colluvium include red maple, black locust, speckled adler, staghorn sumac, silky dogwood, purple flowering raspberry, and a mixture of forbs and grasses. The colluvial vegetation is rapidly decimated by wave action and cannot be considered a stable community. At the mouth of Turkey Creek deltaic deposits can be found which support sedges, cattails, and willows.

2.764
Study site No. 6 was established on the lakefront east of Raccoon Creek near the terminus of Rudd Road to characterize the fauna and flora along the lakefront. As noted earlier, vegetation along the bluff crest consisted of secondary growth species while the deltaic deposits and shallow water environment at the mouth of Turkey Creek supported iris, bulrush, cattail, pondweed, arrowhead, and willow. The ravines of small (ephemeral) Lake Erie tributaries were found to support a mixed deciduous woodland consisting of sugar maple, white ash, red oak, walnut, red maple, and basswood.

2.765
The peak use of Lake Erie by water birds began at ice breakup in late March and continued through April. Use of the nearshore areas by waterfowl was confined to the protected areas within the Conneaut Outer Harbor and a small embayment near the terminus of Rudd Road. An increase in the number of gulls was noted along the shoreline in mid-May and may have been related to a smelt run occurring about the same time. Shore nesting species including kingfishers and swallows began appearing just before mid-April and increased in number until mid-June. During the summer months, the Lake Erie shoreline was dominated by ring-billed gulls, herring gulls, bank swallows, rough-winged swallows, and belted kingfishers. A nesting survey conducted along the shoreline between the Conneaut Harbor breakwater and Raccoon Creek on 14 July 1977 revealed a total of seven nesting pairs of kingfishers and 35 colonies of swallows. In mid-September a number of ring-billed and herring gulls again increased with most of the population consisting of immature individuals. Following this peak, gulls declined although Bonapartes gull and the great black-backed gull were observed in late October and mid-November, respectively. Autumn waterfowl activity was brief and intense. On 12 November 1977 hundreds of waterfowl were observed in the near shore areas of Lake Erie adjacent to the site. The moist abundant species were scaup, redhead, merganser, and goldeneye while others included the Canada goose, mallard, pidgeon, pintail, coot, loon, and grebe. Mammals either collected, observed, or identified through other means along the Lakefront include the chipmunk and fox squirrel.

Big Tree Records

2.766
During the survey of Lakefront site flora several trees were found that were larger than the Pennsylvania State record. A cottonwood tree situated in the northeast corner of the Lakefront site was found to exceed the State record for that species. Similarly, three record-size red maple trees were also recorded. One large specimen is located southwest of the intersection of Rudd Road and Childs Road and is in poor condition. A second specimen is located in Study Area No. 8 while the third is located to the west of Childs Road and Turkey Creek near Study Area No. 9. The circumference, height, and average crown spread for each tree is recorded in Table 2-396(refer to Figure 2-138(a).

TABLE 2-396

Record Trees of the Proposed Lakefront Site

Tree Species	Circumference at 4.5' (feet)	Height (feet)	Average Crown Spread (feet)
Cottonwood			
Lakefront Site	17'10"	100'	104'
Present State Record	13'6"	88'	43'
Red Maple			
Lakefront Site			
Specimen 2	13'1"	67'	60'
Specimen 3	13'8"	84'	78'
Specimen 4	17'6"	70'	76'
Present State Record	12'7"	100'	42'

Fauna of the Lakefront Site

2.767
Insects and Arthropods - During the on-site sampling effort AEA collected over 125,000 insects and related invertebrates representing 25 different orders and 234 families. Collection of these organisms was accomplished using black light, pitfalls, sweep nets, D-vac, malaise traps, and random pickups and observations.

2.768
Within the forested portion of the Lakefront Plant Study Area No. 7 exhibited the largest concentration of the isopod Ligidium elrodii which is one of the few native North American sowbugs. This study area also contained the largest number of giant silkworm moths

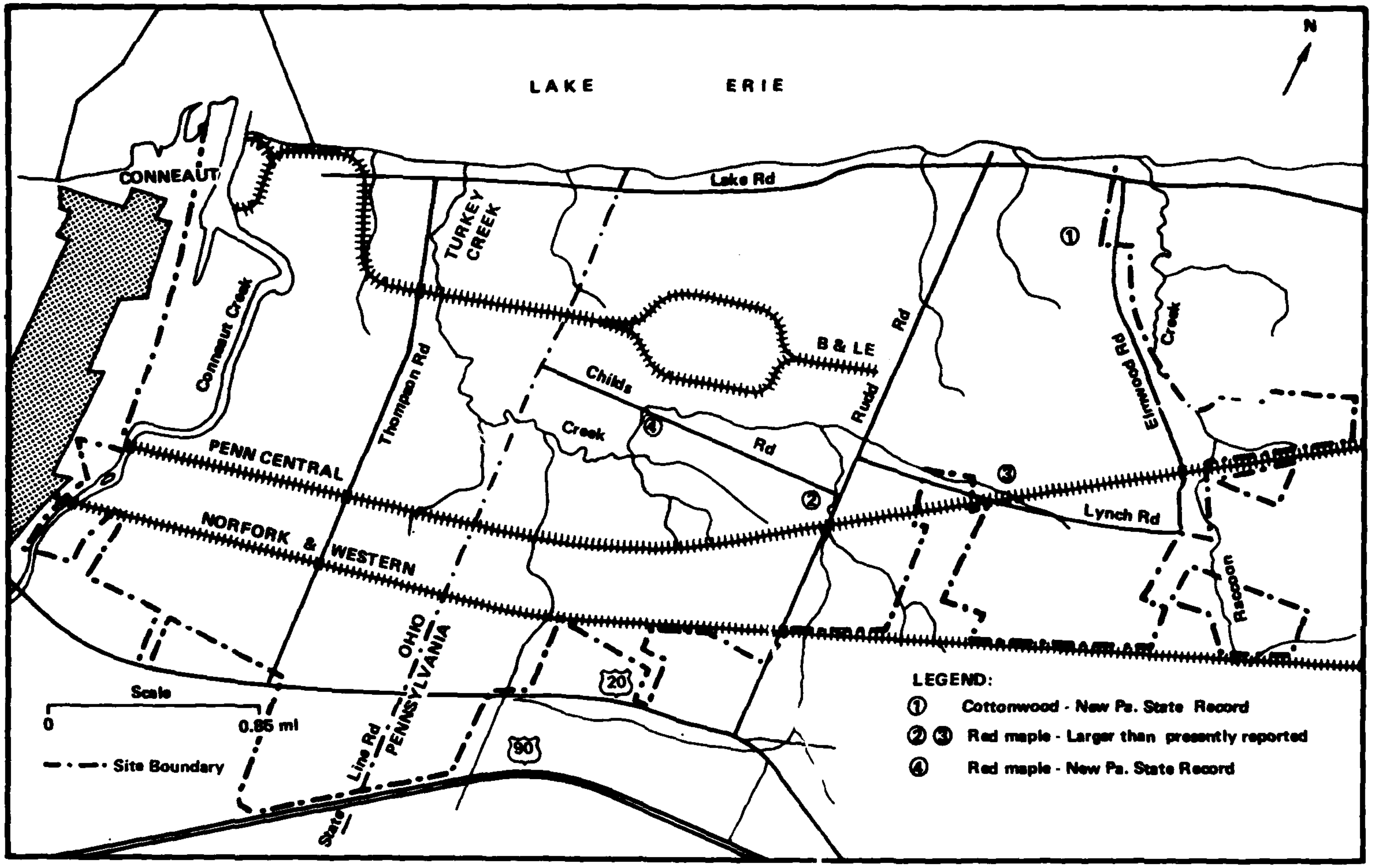


Figure 2-133(a) LOCATION OF PENNSYLVANIA NEW "BIG TREE" RECORDS FOUND AT THE PROPOSED PLANT SITE

(family Saturniidae). Species collected at this location include the prometha moth (Callosamia prome) and the cecropia moth (Hyalophora cecropia). At Study Area No. 1 water scavenger beetles (family Hydrophilidae) were most abundant during the late summer along with the predaceous diving beetle (family Dytiscidae). All study areas within the forest cover type were inhabited by various mosquito species. Study Area No. 3 contained mostly stream insects with stoneflies (Plecoptera) and mayflies (Ephemoroptera) most common. In September the highest number of leaf hoppers (family Cicadellidae) occurred in this study area while the noctuid moths were most abundant during early summer.

2.769
Open area portions of the Lakefront site are somewhat different than the forested areas. Within Study Area No. 4 plant bugs (Hemiptera) and leaf hoppers (Homoptera) were abundant in the early summer along with predacious diving beetles and water scavenger beetles, and water boatmen which inhabited the pools of standing water. Dragonflies and damselflies were common at this site as were mound building ants and grasshoppers. At Area No. 5, the youngest successional stage, Chrysomelidae beetle larvae, plant bugs (Hemiptera and Cicadellidae) and leaf hoppers (Homoptera) were most abundant during mid-summer while grasshoppers (Orthoptera) were numerous during the autumn. The shrublands of Area No. 9 were dominated by insect life similar to the study areas previously described although the greatest diversity of bees and wasps occurred at this location.

2.770
Insects and arthropods were also collected at Area No. 10 which was not a designated vegetation study site. This sampling area is located in the grasslands near the intersection of Lake Road and Rudd Road (refer to Figure 2-135). At this location, leaf bugs (Miridae), seed bugs (Lygaeidae) and thrips (Thysanoptera), short-horned grasshoppers (Acrididae) and four-jawed spiders (Tetragnathidae) were abundant during late summer. Also encountered during this investigation were several species of the families Mymaridae (fairy flies) and Eulophidae. The Mymaridae are minute in size and generally feed on aquatic or terrestrial insect eggs while the Eulophidae larvae parasites on other insects. Sampling efforts along the beaches and lake bluff of Area No. 6 were hampered by intense wave action or high winds. However, results indicate that midges (Chironomidae) are most abundant. At Study Area Site 6A (refer to figure 2-135) a light trap was installed. During its operation large numbers of caddis flies (Trichoptera) and mayflies (ephemeroptera) were collected along with ground beetles (Carabidae), shining flower beetles (Phalacridae), and ant-like flower beetles (Anthicidae) were encountered most frequently. Throughout the sampling period no species were collected which are classified as threatened or endangered by the Federal or State governments.

2.771
Reptiles and Amphibians - The basic technique used to inventory Lakefront Site reptiles and amphibians consisted of searching through suitable habitat during the spring and summer months. In addition to collecting adults, larval forms and eggs mating calls were also used to identify amphibians and determine there relative abundance. Reptiles were located by searching creekbanks, swamps, and other similar habitat. A list of reptiles and amphibians actually collected during the AEA sampling effort is presented in Table 2-397.

2.772
Although the Lakefront Site is poorly drained, the soils are subject to rapid surface drying. Under these conditions successful reproduction of the amphibian population is generally restricted to area drainage ditches, farm ponds, and the wetland sites designated in Figure 2-138. Similarly, the lack of a mature tree canopy and the absence of a dense layer of humus or litter over much of the site generally restricts reptilian population to the Turkey Creek ravine and the wetter portions of the site near Elmwood Road. During this survey no species were found that are listed on the Department of Interior Fish and Wildlife Service List of Endangered and Threatened Wildlife (1977). In addition, no species were encountered which appear on the Pennsylvania Fish Commission List of Endangered, Threatened or Indeterminate Fishes, Amphibians or Reptiles of Pennsylvania (1977). However, the spotted turtle (Clemys guttata) which is identified on the State of Ohio Endangered Wild Animal List, was found on the Lakefront Plant Site.

Avifauna

2.773
Bird populations of the Lakefront site were inventoried using the census tract method. Strip census tracts were established within or near each vegetation study area so that systematic observations of birdlife could be accomplished on a routine basis. These data were augmented by observations made along designated road census tracts. The intent of this survey effort was to record the species present, determine the activity in which it was engaged when sighted (i.e., nesting, foraging, migrating, etc.), record the vegetation cover type in which it predominated, and estimate the time the species occupied the proposed site. The location of the strip and road census tracts is shown in Figures 2-139 and 2-140, respectively. The relationship of the avian species to the types of vegetation encountered at the Lakefront site is presented earlier in this section. The importance of the site for migratory birds is discussed in paragraphs 2.761 and 2.762. The December 1977 AEA Preliminary Final Draft Report discussed the attractiveness of the area to migratory raptors citing

Table 2-397

Amphibians and Reptiles Collected or Identified Within the Proposed Lakefront Plant Site Area

Common Name	Specific Name
Class Amphibia	
Proteidae	
* Mudpuppy	*Necturus Maculosus*
Salamandridae	
* Red Spotted Newt	*Notophthalmus viridescens*
Ambystomatidae	
Jefferson Salamander	*Ambystoma jeffersonianum*
* Spotted Salamander	*Ambystoma maculatum*
Plethodontidae	
o Dusky Salamander	*Desmognathus fuscus*
o Allegheny Mountain Salamander	*Desmognathus ochrophaeus*
* Red-Backed Salamander	*Plenthodon cinereus*
* Slimy Salamander	*Plenthodon glutinosus*
* Two-lined Salamander	*Eurycea bislineata*
Bufonidae	
* American Toad	*Bufo americanus*
Hylidae	
* Spring Peeper	*Hyla crucifer*
* Gray Tree Frog	*Hyla versicolor*
Ranidae	
* Leopard Frog	*Rana pipiens*
* Green Frog	*Rana clamitans*
* Wood Frog	*Rana sylvatica*
* Bullfrog	*Rana catesbeiana*

Table 2-397 (Continued)

Common Name	Specific Name
Class Reptilia	
Chelydridae	
* Snapping Turtle	*Chelydra serpentina*
Emydidae	
* Spotted Turtle++	*Clemmys guttata*
* Painted Turtle	*Chrysemys picta*
Kinosternidae	
* Stinkpot	*Sternotherus odoratus*
Colubridae	
Red-bellied Snake	*Storeria occipitomaculata*
* Northern Brown Snake	*Storeria dekayi*
* Northern Water Snake	*Natrix sipedon*
* Eastern Garter Snake	*Thamnophis sirtalis*
* Eastern Milk Snake	*Lampropeltis triangulum*

* Recorded from the site as of May 31, 1977
Recorded from the site as of June 15, 1977
o Recorded from the site as of Sept. 15, 1977
++ Recorded on the Endangered Wild Animals in Ohio List (1974)

Source: Aquatic Ecology Associates.

Table 2-398

Relative Abundance, Period of Residence and Distribution of Bird Species Observed within the Proposed Lakefront Plant Site

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Status on Site: Distribution (See Figure K-1)
Common Loon	*Gavia immer immer* (Brunnich)	Common	Breeds along lakes and rivers north of the Great Lakes	Rare	T	6, S_1
Horned Grebe	*Columbus auritus* (Linnaeus)	Common	Breeds on lakes and ponds north and west of Great Lakes	Uncommon	T	6
Eared Grebe	*Podiceps caspicus californicus* (Heerman)	Common	Breeds in shallow lakes in western N.A.	Accidental	V	6
Pied-billed Grebe	*Podilymbus podiceps podiceps* (Linnaeus)	Common	Breeds in shallow freshwater over much of central and eastern N.A.	Uncommon	T	6
Double-crested Cormorant	*Phalacrocorax auritus auritus* Lesson	Common	Breeds on inland lakes and rivers in mid-continent and along coasts.	Rare	T	6
Eastern Great Blue Heron	*Ardea herodias herodias* (Linnaeus)	Common	Breeds near fresh and salt water often in colonies	Uncommon Does not nest, but forages on site	T, SR	2, 3, 4, 5, 9, T_2, R_1, B Ch
Eastern Green Heron	*Butorides virescens virescens* (Linnaeus)	Common	Breeds in fresh and salt water in small ponds and along wooded streams	Uncommon	SR	4, 5, 9 B, Ch
Whistling Swan	*Cygnus columbianus* (Ord)	Uncommon	Breeds in far north on tundra	Rare	T	6, 4
Canada Goose	*Branta canadensis interior* (Todd)	Common	Breeds on lake shores and in marshes of western and northern N.A. Several local breeding populations established within 70 mile radius of site	Uncommon	T	4, 6 P, Sl_2

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Status on Site: Distribution
Brant	*Branta bernicla horta* (Muller)	Common	Breeds in artic.	Rare	T	6
Mallard	*Anas platyrhynchos platyrhynchos* (Linnaeus)	Common	Breeds in ponds and freshwater marshes over much of northern N.A.	Uncommon-Common	PR	1, 3, 4, 5, 6, 7, 9, T_3, S_1, E, La_3, La_2, T_1, T_2, R_2
Black Duck	*Anas rubripes* (Brewster)	Common	Breeds in shallow ponds and coastal waters of northeastern N.A.	Uncommon	T, SR	4, 6
Northern Pintail	*Anas acuta* (Vieillot)	Common	Breeds on lakes and ponds over much of the northern half of North America.	Rare	T	4
Gadwall	*Anas strepera* (Linnaeus)	Uncommon	Breeds in West-Central N.A.	Uncommon	T	6
American Widgeon	*Mareca americana* (Gmelin)	Common	Nests in marshes especially in north western and north central North America.	Rare	T	6
Blue-wing Teal	*Anas discors* (Linnaeus)	Common	Breeds in ponds and marshes to west and north of Great Lakes	Rare	T	6 La_2
Wood duck	*Aix sponsa* (Linnaeus)	Common	Breeds in cavities along wooded lakes and streams	Uncommon	T, SR	3, 4, 7 T_3, T_1
Redhead Duck	*Aytha americana* (Eyton)	Uncommon	Breeds in potholes of northern plains	Uncommon	T	6
Ring-necked Duck	*Aythya collaris* (Donovan)	Common	Breeds in woodland ponds north, west and east of Great Lakes	Rare	T	6

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Distribution
Canvas-back Duck	*Aythya valisneria* (Wilson)	Uncommon	Breeds in potholes and lakes of northern plains.	Rare	T	6
Scaup	*Aythya* sp.	Common to abundant	Breeds in northwestern N.A.	Common	T	6
Common Goldeneye	*Bucephala clangula americana* (Bonaparte)	Common	Nests in cavities on forested lakes and rivers across northern N.A.	Common	T	6
Bufflehead	*Bucephala albeola* (Linnaeus)	Common	Breeds on wooded lakes and rivers of northwestern N.A.	Common	T	6
Black Scoter	*Melinitta nigra*	Uncommon	Nests on coast of Alaska, west coast of Hudson's Bay & coasts of Labrador and Newfoundland.	Rare	T, WV	6
White-winged Scoter	*Melanitta deglandi* (Bonaparte)	Common to abundant	Breeds on lakes of northwestern N.A.	Rare	T	6
Ruddy Duck	*Oxyura jamaicensis rubida* (Wilson)	Common	Breeds on lakes in west central N.A.	Uncommon	T	6
Common Merganser	*Mergus merganser americanus* (Cassin)	Common	Breeds in a belt across N.A. north of Great Lakes to southern Alaska	Common	T	6
Red-breasted Merganser	*Mergus serrator serrator*	Common	Breeds from Gulf of St. Lawrence to northern Alaska	Common to abundant	T	6
Hooded Merganser	*Lophodytes cucullatus* (Linneaus)	Uncommon	Nests on wooded lakes and streams in an east-west belt across central N.A.	Rare	T, WV	6

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence	Status on Site: Distribution
Eastern Turkey Vulture	*Cathartes aura septentrionalis* (Wind)	Common	Breeds over central and southern N.A.	Common T, SR No known nests on site	1, 2, 5, 7, 9, T_2, S_2, R_1, E, La_3, Ch, C_R, La_2, Ly_1, P
Cooper's Hawk	*Accipiter cooperii* (Bonaparte)	Uncommon	Nests in woodlands and woods margins over much of southern and central N.A.	Uncommon to T Rare	B
Sharp-shinned Hawk	*Accipiter straitus velox* (Wilson)	Common	Breeds in woodlands and woods margins over much of N.A.	Common T Rare PR	4, 7, 8, 9, P
Eastern Red-tailed Hawk	*Buteo jamaicensis borealis* (Gmelin)	Common	Breeds in woodlands	Common T, PR	1, 4, 5, 8, T_3, S_2, Ch, Ly_2, T_1, S_1, S_3, R_1, R_2, La_3, B, P, La_3.
Broad-winged Hawk	*Buteo platypterus platypterus* (Vieillot)	Common	Breeds in woodland over eastern N.A. from Gaspe Peninsula southward	Common T Rare SR	2, 7 S_2, R_2, La_1, La_3, Ch S_1
Northern Harrier (Marsh Hawk)	*Circus cyaneus hudsonius* (Linnaeus)	Common	Breeds in vicinity of grasslands and marshes over much of central and northern N.A.	Common T Uncommon SR	4, 5 R_1, T_1, La_3
Osprey	*Pandion haliaetus carolinensis* (Gmelin)	Uncommon	Breeds along seacoasts, lakes, and rivers over eastern, western, and northern N.A.	Rare to Uncommon T	6
American Kestrel (Sparrow Hawk)	*Falco sparverius sparverius* (Linnaeus)	Common	Breeds in wooded habitats over much of N.A.	Common T, PR	2, 4, 5, 9, T_1, S_1, La_2, P
Ruffed Grouse	*Bonasa umbellus monticola* (Todd)	Uncommon to Common	Nests especially in open woods or wood edges	Common PR	1, 2, 3, 7, 8, R_1 C_R, E, Ch, S_2, T_1

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Distribution
Ring-necked Pheasant	*Phasianus colchicus* (Linnaeus)	Common	Resident in open woods and farmlands across central N.A. (Introduced)	Rare	PR	Ly_2, S_2, R_2
Eastern Turkey	*Meleagris galloparo silvestris* (Vieillot)	Locally Common	Breeds in open woodland or forest over central and southeastern N.A.	Rare	PR	E, La_2
Herring Gull	*Larus argentatus smithsonianus* (Coues)	Abundant	Breeds along coasts, lakes, and rivers over most of N.A.	Common	T, PR	5, 6 S_1
Ring-billed Gull	*Larus delawarensis* (Ord)	Common	Breeds inland along lakes and rivers over much of central N.A.	Abundant	T, PR	4, 5, 6, S_1
Bonaparte's Gull	*Larus philadelphia* (Ord)	Common	Breeds inland on lakes and rivers of northwestern N.A.	Abundant	T	6
Caspian Tern	*Hydroprogne caspia* (Pallas)	Common	Breeds coastally and inland in eastern, north central, and western N.A.	Rare	T	6
Rock Dove	*Columba livia* (Gmelin)	Common (Introduced)	Nests on buildings and ledges over much of N.A. from tree-line southward	Common	PR	2, 4, 5, 6 T_3, S_1, La_2, La_3 T_1, S_2, S_3, R_2, Ch Ly_2
Eastern Mourning Dove	*Zenaidura macroura carolinensis* Linnaeus)	Common	Breeds in open woodlands, farmlands, and suburbs	Common	T, SR	1, 4, 5, 9 T_1, S_3, R_1, R_2, La_1 La_2, La_3, Ch, T_2, S, Ly_1, Ly_2, P
Yellow-billed Cuckoo	*Coccyzus americannus americannus* (Linnaeus)	Common	Nests in woodlands over much of southern half of N.A.	Rare	T, SR	La_1
Great Horned Owl	*Bubo virginianus virginianus* (Gmelin)	Common	Breeds in wooded habitats over most of N.A.	Common	PR	1, 4, 8 T_3, S_1

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Distribution
Northern Barred Owl	*Strix varia varia* (Barton)	Common	Nests in swamps or river bottoms over much of central and eastern N.A. south of James Bay	Common	PR	2, 3, 4, 7, 8 E
Common Night Hawk	*Chordeiles minor minor* (Forsler)	Common	Nests over much of N.A.	Rare	T	R_2
Sora	*Porzana carolina* (Linnaeus)	Common	Breeds in Marshes especially fresh water with dense vegetation over much of central N.A. from coast	Rare	T	4
American Coot	*Fulica americana americana* (Gmelin)	Common	Breeds on fresh water ponds, lakes and rivers over much of central N.A.	Uncommon	T	6
Killdeer	*Charadrius vociferus vociferus* (Linnaeus)	Common	Breeds in fields and pastures over much of central and southern N.A.	Common	T, SR	4, 5, T_2, R_1, C_R, Ly_2, P, R_2
American Woodcock	*Philohela minor* (Gmelin)	Common	Breeds in moist woodlands, swamps, and thickets	Common	T, SR	1, 2, 4, 7 8, 9 T_1, T_2, T_3, S_1, S_2 S_3, E, La_3, Ch, P
Common Snipe	*Capella gallinago delicata* (Ord)	Common	Breeds in marshes, bogs, and along river banks	Common	T, SR	4, 5 T_2, S_2, S_3
Spotted Sandpiper	*Actitis macularia* (Linnaeus)	Common	Breeds along fresh water streams, lakes, and ponds	Common	T, SR	4, 6
Eastern Solitary Sandpiper	*Tringa solitaria solitaria* (Wilson)	Common	Breeds along streams, lakes, and swamps near the limit of trees	Uncommon	T	4

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence	Status on Site: Distribution
Glaucous Gull	*Larus hyperboreus hyperboreus* (Linnaeus)	Uncommon	Breeds along coasts in Arctic	Rare T, Winter visitor	6, La_1, La_2, La_3
Great Black-backed Gull	*Larus marinus* (Linnaeus)	Common	Nests on northeast coasts of N.A.	Uncommon to WV Rare	6
Chimney Swift	*Chaetura pelagica* (Linnaeus)	Common	Nests in chimneys or hollow trees in eastern N.A. south of Great Lakes	Common T, SR	1, 2, 3, 4, 5 T_1 T_2, S_1, S_2, S_3, R_1, R_2, La_1, La_2, La_3, Ch, Ly_1
Ruby-throated Hummingbird	*Archilochus colubris* (Linnaeus)	Common	Breeds in woodlands, farmlands, and suburbs over eastern N.A. south of the Great Lakes and Gulf of St. Lawrence	Common T, SR	1, 2 T_1, T_3, S_2, C_R, E, La_3, B, P, Ch, S_3, R_2, La_2
Eastern Belted Kingfisher	*Megaceryl ealoyon aloyon* (Linnaeus)	Common	Breeds along lakes, streams, and rivers	Common T, SR	2, 3, 4, 6, 8 T_1, E, La_1, B, P, La_3
Common Flicker (Northern Yellow Shafted Flicker)	*Colaptes auratus auratus*	Common	Breeds in open woodlands with large trees over eastern, north central, and western N.A.	Abundant T, SR	1, 2, 3, 4, 5, 7, 8, 9, T_1, T_2, S_2, R_1, R_2, C_R, E, La_1, La_2, La_3, Ly_2, S_1, B, Ch
Northern Pileated Woodpecker	*Dryocopus pileatus abieticola* (Bangs)	Uncommon	Breeds in extensive deciduous or mixed forests with mature trees	Rare PR	7, E, Ch
Eastern Red-headed Woodpecker	*Melanerpes erythrocephalus erythrocephalus* (Linnaeus)	Uncommon	Breeds in open deciduous woods	Uncommon T, SR	9, T_1, T_2, R_1, R_2, La_3, La_2
Yellow-bellied Sapsucker	*Sphyrapicus varius varius* (Linnaeus)	Common	Breeds in deciduous and mixed woodlands and orchards	Common T, SR	1, 3, 5, 7, 8, T_1, R_2, La_3, B
Eastern Hairy Woodpecker	*Dendrocopus villosus villosus* (Linnaeus)	Common	Nests in mature deciduous or mixed forests	Common PR	2, 7, 3 T_3, C_R, E, T_1

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Distribution
Northern Downy Woodpecker	*Dendrocopus pubescens medianus* (Swainson)	Common	Nests in woodlands, orchards, and suburbs	Common	PR	1, 2, 3, 4, 5, 8, 9 T_3, S_2, E, La_1, La_3, Ly_1, T_1, T_2, R_2, La_2, Ch
Eastern Kingbird	*Tyrannus tyrannus* (Linnaeus)	Common	Breeds in open country and farmland over much of eastern N.A. east of the Great Plains	Uncommon	T, SR	5 S_1, R_1, La_2, La_3, Ly_1, P
Northern Crested Flycatcher	*Myiarchus crinitus boreus* (Bangs)	Common	Breeds in deciduous and mixed woods	Common	T, SR	3, 8, 1 T_1, S_2, S_3, R_1, C_R, La_3, Ch, Ly_1, P
Eastern Phoebe	*Sayornis phoebe* (Latham)	Common	Breeds on buildings, bridges, and other structures	Common	T, SR	4, 5, 7, 8 S_2, R_1, R_2, La_3, Ch T_1, S_3, La_1, La_2, Ly_2,
Acadian Flycatcher	*Empidonax virescens* (Vieillot)	Common	Nests in moist woodlands, especially deciduous flood-plain forests	Common	T, SR	1, 3, 7, 6, 8 E, La_3, S_1
Traills Flycatcher	*Empidonax traillii traillii* (Brewster)	Common	Nests in shrubby vegetation and woods margins	Common	T, SR	2, 4, 5, 9, 8 T_3, S_1, R_2, La_1, La_2, La_3, Ch, Ly_1, P, S_2
Least Flycatcher	*Empirdonax minimus* (Baird)	Common	Nests in scrub growth, wood margins, and orchards	Rare	T, SR	4, 5, 7 La_2, B
Eastern Wood Pewee	*Contopus virens* (Linnaeus)	Common	Nests in deciduous and mixed woods	Common	T, SR	1, 2, 7, 8 3 T_1, T_2, T_3, S_1, S_2 R_1, E, La_1, La_2, La_3, B, Ch, S_3, R_2, Cr, Ly_1, Ly_2
Olive-sided Flycatcher	*Nuttallornis borealis* (Swainson)	Uncommon to common	Breeds in northern coniferous woods across N.A. and southward in western mountains	Rare	Tl	T_3

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Status on Site: Distribution
Horned Lark	*Eremophila alpestris*	Common	Nests in open places over most of northern N.A.	Rare	T	S_1
Tree Swallow	*Iridoprocne bicolor* (Vieillot)	Common	Nests in tree cavities or nest boxes usually near water	Common Rare	T SR	2, 3, 4, 5, 6, 7, 9 La_2
Bank Swallow	*Riparia riparia riparia* (Linnaeus)	Abundant	Nests in burrows in steep water-side banks	Abundant	T, SR	4, 5, 6, T_1, S_1, S_2, R_1, C_R, E, La_1, La_2, La_3, B, Ch, Ly_1, P, R_2, Ly_2
Eastern Rough-winged Swallow	*Stelgidopteryx ruficollis serripenis* (Audubon)	Uncommon to *common*	Nests in burrows, drainpipes, and bridges near water	Common	T, SR	5, 6, R_1, La_1, La_2, La_3
Barn Swallow	*Hirundo rustica erythrogaster* (Boddaert)	Common	Nests on buildings and other structures over most of N.A. south of the limit of trees	Common	T, SR	4, 5, 9, S_1, R_1, R_2, La_3, Ly_1, Ly_2, T_1, T_2, S_2, E S_2, S_3
Purple Martin	*Progne subis subis* (Linnaeus)	Common	Nests in southern N.A. except for Rocky Mountains	Uncommon	T, SR	4, 5, 6, 9 T_1, R_2, La_1, La_3, Ch, S_1, La_2
Northern Blue Jay	*Cyano citta cristata* (Oberholser)	Common	Resident and nests in deciduous and mixed woods, farmland, and suburbs	Common	T, PR	1, 2, 3, 4, 5, 7, 8, 9, T_2, R_1, R_2, La_1, Ch, La_2, La_3, B, Ly_1, P, T_1, T_3, S_1, S_2, E
Eastern Crow	*Corvus brachyrhynchos brachyrhynchos* (Brehm)	Common	Breeds in deciduous and mixed woods and farmland	Common Uncommon	T, SR WR	1, 2, 3, 4, 5, 6, 7, 8, 9, T_2, T_3, S_2, S_3, R_1, R_2, E, La_1, La_2, La_3, Ch, Ly_2, S_1, B, Ly_1, P, C_R
Eastern Black-capped Chickadee	*Parus articapillus articapillus* (Linnaeus)	Common	Breeds in cavities in deciduous and mixed woods	Common	PR	1, 2, 3, 4, 5, 7, 8, 9, T_1, T_2, T_3, R_2, E, La_1, La_2, B, Ly_1, S_1, S_3, R_1, Cr, La_3, S_2, Ch
Tufted Titmouse	*Parus bicolor* (Linnaeus)	Common	Nests in cavities in deciduous woodlands	Uncommon	PR	7, 8, 9, La_3

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Distribution
Eastern White-breasted Nuthatch	*Sitta carolinensis cookei* (Oberholser)	Common	Nests in cavities in deciduous woodlands	Common	PR	1, 2, 3, 4, 8, T_1, T_2, T_3, S_2, R_1, R_2, La_2, La_3
Red-breasted Nuthatch	*Sitta canadensis* (Linnaeus)	Common	Nests preferentially *in coniferous wood-lands*	Uncommon	T, WR	1, 3, 7, 8, 4, T_1, T_2 E, La_1, La_2, La_3
Eastern Brown Creeper	*Certhia familiaris americana* (Bonaparte)	Common	Nests in northern deciduous or mixed deciduous-coniferous forests	*Rare to* Common	T	1, 3, 4, 8, T_3, La_2, T_1, T_2, R_1, La_3
Eastern House Wren	*Troglodytes aedon aedon* (Vieillot)	Common	Nests in cavities in deciduous woodlands *especially shrubby* woods and in nest b xe in farmland a. suburbs	Abundant	SR	1, 2, 3, 5, 7, 9, 8, T_1, T_3, S_3, R_1, R_2, C_g, La_1, La_3, Ch, Ly_1, Ly_2, P, S_2, La_2, B
Eastern Winter Wren	*Troglodytes troglodytes hiemalis* (Vieillot)	Uncommon	Nests in brush piles or thick undergrowth in moist forests	Rare	T	3, 4, B
Long-billed Marsh Wren	*Telmatodytes palustris palustris*	Abundant	Nests in sedge and cattail marshes from coast to coast across Central N.A.	Rare	T	T_1
Northern Mockingbird	*Mimus polyglottos polyglottos* (Linnaeus)	Common	Nests over much of southern half of N.A.	Rare	T	La_1
Gray Catbird	*Dumatella carolinensis* (Linnaeus)	Common	Nests in dense under-growth of deciduous woods, woods margins, and suburbs	Abundant	T, SR	All locations but 6
Eastern Brown Thrasher	*Toxostoma rufum rufum* (Linnaeus)	Common	Nests, usually in vines near ground in dense undergrowth of woods margins, hedgerows, etc.	Uncommon	T, SR	2, 4, 5, S_2, La_2, Ly_2, Ch

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Status on Site: Distribution
American Robin	*Turdus migratorius migratorius* (Linnaeus)	Common	Nests in woods, woods margins, and open areas near farms and suburbs	Abundant	T, SR	All locations but 6
Wood Thrush	*Hylocichla mustelina* (Gmelin)	Common	Nests in eastern deciduous forests and suburbs	Abundant	T, SR	All locations but 6, S_3, and P, Ly_2
Eastern Hermit Thrush	*Catharus guttatus faxoni* (Bangs and Pennard)	Common	Nests in northern woodlands, prefers mixed deciduous coniferous	Rare	T	8, 4, E, T_1
Swainson's Thrush	*Catharus ustulatus swainsoni* (Tschudi)	Common	Breeds in coniferous forests	Uncommon	T	2, 3, 7, 8, 4, T_1
Gray-cheeked Thrush	*Catharus minimus* (Lafresnaye)	Uncommon	Nests across northern quarter of N.A. from coast to coast	Rare	T	
Veery	*Hylocichla fuscesens fuscesens* (Stephens)	Common	Nests in deciduous woodlands, prefers wetter habitats	Common	T, SR	1, 2, 3, 7, 8, 5, 9, T_1, T_2, T_3, S_2, R_1, R_2, C_R, E, La_1, B, Ch, Ly_1, Ly_2, La_1, La_2
Eastern Bluebird	*Sialia sialia sialia* (Linnaeus)	Uncommon to Common	Nests in cavities in open woodland, especially along roadside, farmland, and abandoned orchards	Rare	T	La_2, R_1
Blue-gray Gnatcatcher	*Polioptila caerula caerula* (Linnaeus)	Common	Nests in treetops of moist deciduous forests	Uncommon	T, SR	2, 7 S_2, R_1
Eastern Golden-crowned Kinglet	*Regulus satrapa satrapa* (Lichtenstein)	Common	Nests preferentially in coniferous woodlands	Rare	T	7, S_1, T_1, La_2, La_3
Ruby-crowned Kinglet	*Regulus calendula calendula* (Linnaeus)	Common	Nests preferentially in coniferous woodlands	Uncommon	T	1, 2, 7, 4 La_2, La_3, T_1, R_2
Water Pipit	*Anthus spinoletta rubescens* (Tunstall)	Common	Nests in open spaces in extreme northern and western N.A.	Rare	T	S_1

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Status on Site: Distribution
Cedar Waxwing	*Bombycilla cedorum* (Vieillot)	Common	Nests in open deciduous or mixed woodlands, wood margins, or orchards	Common	T, SR	2, 4, 5 T_1, T_2, T_3, S_1, S_3, R_2, C_R, La_1, La_2, La_3, B, Ch, Ly_1, Ly_2, S_2, R_1, P
Loggerhead Shrike	*Lanius ludoviciannus migrans* (Palmer)	Uncommon	Nests in thorny trees, hedges, or thickets	Rare	T	4 R_1, S_1, S_3, Ly_2
Starling	*Sturnus vulgaris vulgaris* (Linnaeus)	Common to Abundant	Nests in tree cavities, houses, eaves, steeples, etc.	Common	PR	2, 4, 5, 8 R_2, La_1, La_2, La_3, Ly_1, Ly_2, P, T_1, T_2, S_1, S_2, R_1, T_3
Solitary Vireo	*Vireo solitarius solitarius* (Wilson)	Common	Nests in mixed northern hardwood-conifer forests	Rare	T	T_1
Northern White-eyed Vireo	*Vireo griseus noveboracensis* (Gmelin)	Common	Nests in dense, moist, deciduous, thickets, wood margins, and hedgerows	Uncommon	T, SR	9
Yellow-throated Vireo	*Vireo flavifrons* (Vieillot)	Uncommon	Nests in deciduous forests near water, in clearings, shade trees, and in mixed deciduous-coniferous woods	Rare	T, SR	3 S_2
Red-eyed Vireo	*Vireo olivaceous* (Linnaeus)	Abundant	Nests in high canopy of deciduous forests	Abundant	T, SR	1, 2, 3, 7, 8, 4, 5, All locations except Ly_2
Eastern Warbling Vireo	*Vireo gilvus gilvus* (Vieillot)	Common	Nests in tall deciduous shade trees	Uncommon	T	R_1, E, R_2, Cr, B, 7, 8
Black and White Warbler	*Mniotilta varia* (Linnaeus)	Common	Nests on ground in deciduous woods	Uncommon	T	3 T, S_2
Golden-winged Warbler	*Vermivora chrysoptera* (Linnaeus)	Uncommon	Nests in young deciduous growth and in abandoned pastures	Rare	T, SR	9 S_1

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Status on Site: Distribution
Blue-winged Warbler	*Vermivora pinus* (Linnaeus)	Uncommon	Nests in old fields overgrown with scattered saplings more than 10 feet tall	Uncommon	T, SR	1, 2, 9 T_3, Ly_1
Brewsters' Warbler	*Vermivora leucobronchialis* (Brewster)	Rare	Non-breeding hybrid of *V. chrysoptera* and *V. pinus*	Rare	T, SR	Ly_1
Tennessee Warbler	*Vermivora peregrina* (Wilson)	Common	Nests in Aspen and Spruce woodlands	Uncommon	T	E, R_1
Nashville Warbler	*Vermivora ruficapilla ruficapilla* (Wilson)	Common	Nests in open second-growth deciduous woods and Spruce bogs	Uncommon	T	1, 5, 7, R_2, T_1, T_2, S_2, La_2, La_3
Eastern Yellow Warbler	*Dendroica petechis aestiva* (Gmelin)	Common	Nests in Willow and dogwood thickets and suburban shrubbery	Abundant	T, SR	3, 4, 5, 4, 9 All locations on road census transects
Magnolia Warbler	*Dendroica magnolia* (Wilson)	Common	Nests in moist Hemlock and Spruce forests	Uncommon	T	1, 9, 8 T_1, T_3, S_2, R_1, La_2
Cape May Warbler	*Dendroica tigrina* (Gmelin)	Uncommon	Nests in Spruce-Fir forests	Uncommon	T	9, 8 T_1, R_1, R_2
Black-throated Blue Warbler	*Dendroica caerulescens caerulescens* (Gmelin)	Common	Nests in coniferous or deciduous undergrowth in Appalacians	Uncommon	T	La_2, T_1, 9
Yellow-rumped Warbler (Myrtle Warbler)	*Dendroica coronata coronata* (Linnaeus)	Abundant	Nests in Spruce-Fir forests	Uncommon	T	2, 3, 7, 4, R_2 T_1, S_2, R_1, E, La_1, La_2 La_3
Black-throated Green Warbler	*Dendroica virens virens* (Gmelin)	Common	Nests in high northern conifers, Oaks, and Cypresses	Uncommon Rare	T SR	3, 8, 4 La_2, T_1, T_2, S_2

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Status on Site: Distribution
Blackburnian Warbler	*Dendroica fusca* (Muller)	Common	Nests in treetops of Spruce-Fir forests or Oaks in Appalachians	Uncommon	T	La_1, 8
Chestnut-sided Warbler	*Dendroica pensylvanica* (Linnaeus)	Common	Nests in deciduous brush or undergrowth	Uncommon	T, SR	2
Bay-breasted Warbler	*Dendroica castanea* (Wilson)	Common	Nests in northern conifers	Uncommon	T	8 T_1, S_2
Black-poll Warbler	*Dendroica striata* (Forster)	Abundant	Nests in northern coniferous forests	Uncommon	T	8, 7
Palm Warbler	*Dendroica palmarum palmarum* (Gmelin)	Common	Nests on ground in bogs in north-eastern and north central North America	Uncommon	T	4, R_1, R_2, T_1
Eastern Ovenbird	*Seiurus aurocapillus aurocapillus* (Linnaeus)	Common	Nests or ground in deciduous forests	Abundant	T, SR	1, 2, 4, 7, 8 T_2, S_2, R_1, E, P
Northern Waterthrush	*Seiurus noveboracensis*	Common	Nest along northern bogs and water-courses	Rare	T	3, 7 R_1
Northern Yellow-throat	*Geothlypis triclus brachidactyla* (Swainson)	Abundant	Nests in moist grassy or shrubby areas	Abundant	T, SR	1, 2, 3, 4, 5, 8, 9, All locations on road census transects
Hooded Warbler	*Wilsonia citrina* (Boddaert)	Common	Nests in moist deciduous woods with abundant undergrowth	Common	SR	1, 2, 3, 4, 7, 8, T_1, T_2, T_3, E, La_1
Wilson's Warbler	*Wilsonia pusilla pusilla* (Wilson)	Common	Nests especially in Willow thickets in northern and western N.A.	Uncommon	T	T_1, La_2
Canada Warbler	*Wilsonia canadensis* (Linnaeus)	Common	Nests in northern forest undergrowth	Uncommon	T	3

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Distribution
American Redstart	*Setophaga ruticilla ruticilla* (Linnaeus)	Common	Nests in deciduous forests understory especially near water	Common	T, SR	1, 2, 3, 7, 8, 4, T_1 T_2, S_2, R_2, E, La_2, La_3, Ch, Ly_1, R_1, Cr, Ly_1, B, P, La_1
Bobolink	*Dolichonyx oryzivorus* (Linnaeus)	Common	Nests in grassy fields	Common	T, SR	4, 5, R_1, La_2
Eastern Meadowlark	*Sturnella magna magna* (Linnaeus)	Common	Nests in grassy fields	Common	T, SR	4, 5, 7, R_1, La_2, Ly_1, Ly_2, T_1
Eastern Red-winged Blackbird	*Agelaius phoeniceus phoeniceus* (Linneaus)	Abundant	Nests in marshes and grassy fields	Abundant	T, SR	1, 2, 4, 5, 8, 9, T_1, S_1, S_3, R_1, C_R, E, La_1, La_2, La_3, Ly_1 Ly_2, P, T_3
Northern Oriole (Baltimore Oriole)	*Icterus galbula* (Linneaus)	Common	Nests in tall deciduous trees	Common	T, SR	1, 2, 3, 4, 5, 8, T_1, T_2, C_R, La_1, La_2, Ch, Ly_1, Ly_2, P
Rusty Blackbird	*Euphagus carolinus* (Muller)	Common	Nests in northern wooded swamps	Uncommon	T	4, 8, P, R_2
Common Grackle	*Quiscalus quiscala* (Vieillot)	Abundant	Nests in evergreens or large deciduous trees often in colonies	Abundant	T, SR	All locations, T_1, T_2, S_1, R_1, R_2, C_R, E, La_1, B, Ly_1, Ly_2, P, La_2
Eastern Brown-headed Cowbird	*Molothrus ater ater* (Boddaert)	Common	Found in a variety of habitats from farm-land to forest	Common	T, SR	1, 2. 3, 4, 7, 9, 8 T_1, T_2, S_1, S_2, S_3, R_1, R_2, La_1, La_2, La_3, Ly_1, P
Scarlet Tanager	*Piranga olivacea* (Gmelin)	Common	Nests in deciduous and mixed deciduous-coniferous woods	Common	T, SR	1, 3, 7, 8, 4, T_1, S_2, C_R, E, La_3, B, R_1
Eastern Cardinal	*Cardinalis cardinalis* (Linnaeus)	Common	Nests in hedgerows, wood margins and suburbs	Abundant	PR	All locations except 6, and P.

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Distribution
Rose-breasted Grosbeak	*Pheucticus ludovicianus* (Linneaus)	Common	Nests in northern forests, old orchards and suburbs	Common	T, SR	1, 2, 3, 4, 5, 7, 8 T_1, T_2, S_1, R_2, C_R, E, La_2, B, Ch, Ly_1, Ly_2, T_3, La_1
Indigo Bunting	*Passerina cyanea* (Linneaus)	Common	Nests in hedgerows and wood margins	Uncommon	T, SR	T_1, S_2, La_2, Ly_1
Purple Finch	*Carpodacus purpureus purpureus* (Gmelin)		North and west of Great Lakes	Uncommon	T	T_1, S_2, R_1
Pine Siskin	*Carduelis pinus pinus* (Wilson)	Common (Irregular)	Nests especially in conifers over much of western N.A. and north of Great Lakes	Uncommon	T	T_1, S_1, R_1
Eastern Goldfinch	*Carduelis tristis tristis* (Linnaeus)	Common	Nests in weedy fields bushes, and wood margins	Abundant	T	1, 2, 3, 4, 5, 7, 8, 9, T_1, T_2, S_1, S_3, R_1, R_2, La_1, La_2, La_3, B, Ch, Ly_1, Ly_2, S_2
Rufous-sided Towhee	*Pipilo erythrophthalmus* (Linneaus)	Common	Nests in bush, heavy undergrowth, wood margins and open forests	Common	T, SR	All locations except 6 and P.
Eastern Savannah Sparrow	*Passerculus sandvichensis savanna* (Wilson)	Common	Nests in large fields with short, sparse grass or weeds	Rare	T, SR	5, R_1
Eastern Grasshopper Sparrow	*Ammodramus savanarum pratensis* (Viellot)	Common	Nests in grassy and weedy fallow fields	Uncommon	T, SR	5, R_1, La_2
Eastern Vesper Sparrow	*Pooecetes gramineus gramineus* (Gmelin)	Common	Nests in meadows, pastures, and grassy fields	Rare	T	4, Ly_1

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Status on Site: Distribution
Dark-eyed Junco (Slate-colored Junco)	*Junco hyemalis hyemalis* (Linnaeus)	Abundant	Nests in borders of coniferous forests	Common	T, WR	2, 4, 9, La_2, Ch, T_1, T_2, R_1, La_1, B, S_1
Eastern Tree Sparrow	*Spizella arborea arborea*	Common	Nests in conifers and hedgerows	Common	T, WR	2, 3, 4, 8, 9, S_1, S_2, R_1, La_1, La_2, Ch, T_1, R_2, B, La_3
Eastern Chipping Sparrow	*Spizella passerina passerina* (Bechstein)	Common	Nests in scattered trees near openings or clearings	Uncommon	T, SR	2, 4, 9, R_1, La_3 Ly_1, T_1, S_3, R_2
Eastern Field Sparrow	*Spizella pusilla pusilla* (Wilson)	Common	Nests in abandoned fields with tall grass and scattered shrubs or saplings	Common	T, SR	1, 4, 5, 8, 9, 7, T_3, S1, R_1, R_2, C_R, La_2, Ch, Ly_1, Ly_2, P, S_3, La_1
White-crowned Sparrow	*Zonotrichia leucophrys*	Common	Nests on ground in dry, upland situations in coniferous forests	Common	T	2, 4, 5, 9, R_1, R_2 La_2, S_1, La_1
White-throated Sparrow	*Zonotrichia albicollis* (Gmelin)	Abundant	Nests in northern mixed deciduous-coniferous forest	Uncommon	T	2, 4, 7, 8, La_1, La_2, Ch, T_1, T_2, S_2, R_1, R_2, La_3, E
Eastern Fox Sparrow	*Passerella iliaca iliaca* (Merrem)	Common	Nests on ground under northern coniferous forests	Uncommon	T	B, S_1, La_1, R_1
Lincoln's Sparrow	*Melospiza lincolnii lincolnii* (Audubon)	Uncommon	Nests along northern bogs and streams	Rare	T	4, R_1
Eastern Swamp Sparrow	*Melospiza georgiana georgiana* (Latham)	Common	Nests in bogs, marshes and lightly wooded swamps	Common	T, SR	4
Eastern Song Sparrow	*Melospiza Melodia melodia* (Wilson)	Abundant	Nests in moist areas with shrubs, hedgerows and wood margins	Abundant Uncommon	T, SR WR	1, 2, 3, 4, 5, 9, 8 All locations except E

Table 2-398 (Continued)

Common Name	Species	Status in N.A.	Preferred Breeding Habitat	Status on Site: Relative Abundance & Period of Residence		Status on Site: Distribution
Snow Bunting	*Plectrophenax nivalis nivalis* (Linnaeus)	Common	Nests on tundra	Uncommon - Common	WV	4
House Sparrow	*Passer domesticus domesticus* (Linnaeus)	Abundant	Nests near human habitation on farms and in suburbs and cities	Uncommon	PR	Ly_1, La_3

Lake Road - three locations (La_1, La_2, La_3)
B & LE Tracks between Thompson and State Line Roads - one location (B)
Childs Road - one location (Ch)
Lynch Road - two locations (Ly_1, Ly_2)
Penn-Central Tracks south of Area Eight - one location (P)
Thompson Road - three locations (T_1, T_2, T_3)
State Line Road - three locations (S_1, S_2, S_3)
Rudd Road - two locations (R_1, R_2)
Crayton Road - one location (CR)
Elmwood Road - one location (E)

Abundant - indicates that a species was found in very large numbers

Common - the species was found in large numbers

Uncommon - the species was found in small numbers

Rare - the species was found in very small numbers

Casual - the species is slightly beyond its normal range but recorded

Accidental - the species is far beyond its normal range but recorded

Permanent Resident (PR) - the species nests in the area and occurs throughout the year in fairly constant numbers

Summer Resident (SR) - the species nests in the area and occurs there during the summer

Winter Resident (WR) - the species winters in the area

Transient (T) - the species passes through the area in migration but is not resident

Visitor (V) - the species visits the area irregularly and for indefinite periods

Winter Visitor (WV) - the species visits the area for indefinite periods during the winter

STUDY AREAS (as noted in methods section): 1, 2, 3, 4, 5, 6, 7, 8, 9

Source: Aquatic Ecology Associates Preliminary Final Draft Report, Volume 2, December 1977.

observations of bald-eagles in 197'. 1973, and 1974, and gyrfalcons, regarded as an accidental species in 1977, in nearby Lake City, PA. A list of the bird species occupying the Lakefront Plant site and an estimate of the duration of residence is presented in Table 2-398.

Mammals

2.774
Occupation of the proposed Lakefront Plant Site by mammals was determined largely through the actual collection of individuals although physical evidence such as tracks, burrows, and fecal material was also examined. Specimens were collected through the use of such techniques as snap trapping, pitfall trapping, live trapping, and mist netting. Snap traps were generally used for small rodents while shrews and certain burrowing mice were collected in pitfall traps. Live traps were used to collect chipmunks and noctural rodents such as the flying squirrel. Mist netting was employed to collect bats. Mammals were collected along specially designated transects within each vegetation study area. However, to maximize the total number of species collected during the sampling period, traps were placed at various locations throughout the proposed site. A complete list of the species collected during the spring and summer 1977 sampling period is presented in Table 2-399.

Important Game Species of the Lakefront Site

2.775
American Woodcock (Philohela minor) - Woodcock are small birds only slightly larger than a bobwhite quail. They are brown heavily molted, chunky and almost neckless with an extremely long bill. This species is native to North America and has been a valued game bird for over 100 years. In 1918 Federal restrictions were imposed limiting the hunting season and bag limit on this bird. Prior to this time unrestricted hunting including market hunting greatly reduced populations. Woodcock migrate during the spring and fall and may nest in the same location from year to year. Woodcock from the western Pennsylvania and Ohio area winter in Louisiana and Mississippi. The migrating behavior pattern is very similar to that observed with waterfowl except that the woodcock utilize upland habitat. This species exhibits a unique type of courtship and breeding behavior and requires specific habitats both in the north and south. Changing land practices and development of limited habitats has caused a steady decline in its population in most areas since the 1930's. The woodcock is now protected under the Migratory Bird Stamp Act.

2.776
The Lakefront Plant site is located on a plain, which was covered by water following the retreat of the Wisconsin glacial ice from Ohio.

Table 2-399

Mammals Collected at the Lakefront Site (Spring, Summer and Fall)

Species	Common Name	Spring	Summer	Fall
Order Marsupialia				
Didelphis virginiana	Virginia opossum	X	X	X
Order Insectivora				
Sorex cinereus	Masked shrew	X	X	X
Blarina brevicauda	Short-tailed shrew	X	X	X
Parascalops breweri	Hairy-tailed mole	X	X	
Condylura cristata	Star-nosed mole	X	X	
Order Chiroptera				
Myotis keenii	Keen's myotis		X	
Order Lagomorpha				
Sylvilagus floridanus	Eastern cottontail	X	X	X
Order Rodentia				
Tamias striatus	Eastern chipmunk	X	X	X
Marmota monax	Woodchuck	X	X	X
Sciurus niger	Fox squirrel	X	X	X
Tamiasciurus hudsonicus	Red squirrel	X	X	X
Glaucomys volans	Southern flying squirrel		X	
Castor canadensis	Beaver		X	
Peromyscus leucopus	White-footed mouse	X	X	X
Microtus pennsylvanicus	Meadow vole	X	X	X
Ondatra zibethicus	Muskrat	X	X	
Rattus morvegicus	Norway rat			X
Mus musculus	House mouse			X
Zapus hudsonius	Meadow jumping mouse	X	X	X
Napaeozapus insignis	Woodland jumping mouse	X	X	
Order Carnivora				
Vulpes vulpes	Red fox	X	X	X
Urocyon cinereoargenteus	Gray fox	X	X	X
Procyon lotor	Raccoon	X	X	X
Mustela frenata	Long-tailed weasel		X	
Mustela vison	Mink		X	
Mephitis mephitis	Striped skunk	X	X	X
Order Artiodactyla				
Odocoileus virginianus	White-tailed deer	X	X	X
Total number of species collected		24		

Source: Acquatic Ecology Associates, Preliminary Final Draft Report, Volume 2, December 1977.

The soils on this old lake plain are mostly level to gently sloping with the exception of areas adjacent to streams and rivers.

2.777
The major soil association is Conneaut-Swanton-Claverack, which is characterized by deep, nearly level to sloping, poorly drained and moderately well drained silty and sandy soils. These soils were developed on glacial till or lake sediments. Important soil characteristics for woodcock habitats are their loam and silty loam materials and their poorly drained state. The presence of these physical features is important to earthworm production and diversity which is the primary food source for woodcock.

2.778
Lake Erie has a buffering effect on the meteorological factors of the area. Moderating temperatures and adequate precipitation during most years ensures a stable food supply.

2.779
A wide diversity of ecological communities is present at the site. The specific seral ecotypes along with their interspersion and juxaposition are of a high value to wildlife. Specific habitats available at the site are especially suited to woodcock. The area was inventoried and classified into ecological communities to determine the areas of importance to woodcock. (Figure 2-139). This information was supplied by Fahringer, McCarty, Grey, Inc. and analyzed by the Corps staff for this report.

2.780
The ecological types are categorized by the dominant and major secondary "cover" plants, i.e. those occupying the upper levels of stratification. Thus, meadows are said to be dominated by the taller grasses and forbs, thickets by shrubs and small trees, and forests by canopy-level trees. Types dominated by woody plants are further classified by size. Each tree-dominated unit is designated "sapling," "pole-age," "maturing" or "mature" according to estimates of which size class represented in the stand has the greatest aggregate crown coverage. Tree size classes are based on estimates of trunkdiameters 1.4 meters (4.5 feet) above the ground (dbh). Each shrub-dominated unit is designated "young" or "aged" according to a combination of shrub height, degree of canopy closure and abundance of low branches very close to the ground. The manner in which the ecological communities are delineated on the ecological inventory map (Figure 2-139) reflects the findings of extensive field investigation combined with infrared aerial photointerpretation. The acreage of the study area, comprising the 715-hectare (1,766-acre) primary impact area or area which would be altered by proposed construction, is classified quantitatively as follows. (Refer to Table 2-400)

Table 2-400

Breakdown of Primary Impact Area by Ecological Classifications

	Area	Percentage of Total
TREE-DOMINATED SERAL ECOTYPES:		
Aspen	17 hectares (43 acres)	2.5
Swamp/Soft Maple	333 hectares (823 acres)	46.5
Hard Maple	47 hectares (115 acres)	6.5
Northern Hardwoods	21 hectares (52 acres)	3
Upland Oak	5 hectares (13 acres)	1
Altered Woodland	47 hectares (117 acres)	6.5
SHRUB-DOMINATED SERAL ECOTYPES:		
Thicket/Swamp Thicket	58 hectares (143 acres)	8
HERB-DOMINATED SERAL ECOTYPES:		
Meadow/Invaded Meadow/Marsh	121 hectares (300 acres)	17
Lakeshore Bluff	7 hectares (18 acres)	1
ARTIFICIALLY MAINTAINED ECOTYPES:		
Cultivated or Grazed Land	8 hectares (20 acres)	1
Disturbed or Unvegetated Land	50 hectares (123 acres)	7

2.781
Aspen Ecotype. The aspen ecotype on the study area often represents the first tree-dominated stage in seral succession following cultivation or other severe vegetative alteration. The dominant plant by crown coverage is quaking aspen (Populus tremuloides). Sometimes bigtooth aspen (Populus grandidentata) is also present and may in certain cases achieve co-dominance. The two species are ecologically equivalent. Aspens are short-lived species in humid eastern North America where they are nearly always lethally attacked by several species of fungi before attaining maturity. Stands of aspen growing in this region may be classified by size as sapling (less than 10 centimeters dbh), pole-age (10 to 30 centimeters dbh) or mixed sapling and pole-age. Aspen leaf-litter has a distinctive influence upon soil chemistry and ecology. Calcium and nitrogen content, pH and other characteristics of the typical aspen substratum are especially favorable to the prosperity of earthworms. Aspen sapling stands, presumably owing to their lower rate of transpiration relative to more mature stands, often feature exceptionally high earthworm populations very near the soil surface. Earthworms and other soil fauna comprise the bulk of the diet of the American woodcock; sapling aspen stands are highly favored as feeding and brooding habitat for this bird. Ruffed grouse also may utilize sapling aspen stands as cover. The 17 hectares (43 acres) of aspen-dominated cover identified on the ecological inventory map actually does not constitute the total area occupied by this ecotype. Small clumps are distributed on a limited but significant part of the acreage classified as invaded meadow. Where soil conditions are right, these also may have significance as woodcock feeding habitat.

2.782
Swamp and Soft Maple Ecotypes. Red maple (Acer rubrum) and silver maple (Acer saccharenum) are common overstory trees which occur in a wide range of soil moisture conditions. They become the dominant species in wetter areas with lower pH ranges. Black ash (Fraximus nigra) black gum (Nyssa sylvatica) and swamp white oak (Quercus bicolor) are common trees found in these wooded swamp areas. This ecotype is of limited value to most wildlife but can become important during periods of adverse weather. Specialized passerine birds such as warblers, some sparrows and other insectivorous species occupy niches in these areas. Woodcock use of these areas is primarily limited to edges which are adjacent to more suitable habitat.

2.783
Hard Maple Ecotype. This ecotype is representative of upland forest communities in this region. Primary species are American beech (Fagus grandifolia) and sugar maple (Acer saccharum). The secondary canopy and understory is composed mainly of shade tolerant species such as Fraxinus sp. Quercus sp. etc. Seedlings and saplings are an

important source of browse for deer. This ecotype is representative of a more mature state of successional change. Soil pH is usually low and available nutrients limited. These factors reduce earthworm productivity and thus represent areas of low food value to woodcock. Ground cover is also sparse and unsuitable.

2.784
Northern Hardwoods Ecotype. The microclimates of "frost pockets," north and east slopes and ravines favor the growth of a forest type which is much more widespread in cooler climates farther east and north of Lake Erie. Canopy dominance most frequently is shared by sugar maple (Acer saccharum), yellow birch (Betula alleghaniensis), American beech (Fagus grandifolia) and eastern hemlock (Tsuga canadensis). Northern red oak (Quercus rubra) is usually the most common secondary canopy component. Where it occurs on the study area, the northern hardwoods ecotype appears to indicate sites not utilited at any time in the past for the cultivation of crops or for pasture. These areas are of value to deer and ruffed grouse but are not suitable to woodcock.

2.785
Upland Oak Ecotype. The most localized of the ecotypes identified on the study area, the upland oak forest type generally indicates well drained soils where the water table normally remains well below the surface. White oak (Quercus alba) and northern red oak (Quercus rubra) most commonly dominate the canopy. Two less frequent species -- scarlet oak (Quercus coccinea) and black oak (Quercus velutina) -- are somewhat more reliable indicators in this region of excessively drained soils. Small sandy knolls and the rim of the bluff along the lakeshore are the situations most frequently occupied by this type. Soils in these areas are too dry and acid for good earthworm production. Understory plant cover is also limited making these areas of low value to woodcock.

2.786
Altered Woodland Ecotype. The term altered woodlands is used to label tree-dominated seral ecotypes whose canopy composition does not conform to the descriptions given above of the "natural" forest ecotypes native to the region. Their presence may indicate former intensive land uses; most frequently they are remnants of old pastures, farmsteads, dwelling sites or conifer plantations. Altered woodlands often prominently feature plants alien to, or uncommon in, the region. Fruit and nut trees, ornamentals and hedgerow trees and shrubs are common. One of the most frequent indicators of the altered woodland type on the study area is black walnut (Juglans nigra). Others include Osage-orange (Maclura pomifera), apple (Malus pumila), Norway spruce (Picea abies), Scotch pine (Pinus sylvestris),

pear (Pyrus communis), etc. Vegetation composition and soil characteristics largely determine wildlife use. Although these areas are not primary woodcock habitate they are valuable to woodcock during migration. These areas are used by woodcock moving through the area.

2.787
Thicket and Swamp Thicket Ecotypes. The majority of the shrub and small tree-dominated communities on the study area feature either speckled alder (Alnus rugosa) or silky dogwood (Cornus amomum) as upper story dominants. The most important secondary thicket-forming plants are hawthorns (Crataegus spp.), sweet crab apple (Malus coronaria), apple (Malus pumila), staghorn sumac (Rhus typhina), blackberries (Rubus spp.) and northern arrowwood (Viburnum recognitum). Swamp thickets also may be dominated by speckled alder or silky dogwood and frequently include northern arrowwood; the true indicators of swamp thickets, however, are common buttonbush (Cephalanthus occidentalis) and willows (Salix spp.). Thickets often support exceptionally high populations and great species diversity of animal life. Many animals show a definite preference for certain types of thicket habitat for most of their feeding, resting and reproductive activities. Vertebrates in this category include cottontail, woodcock, cuckoos, alder flycatcher, wrens, catbird, brown thrasher, yellow warbler, yellow-breasted chat, indigo bunting and towhee. Overall, thickets are the most productive ecotype present on the study area for species of harvested wildlife. In addition to the cottontail and woodcock, both deer and ruffed grouse utilize brushy areas for feeding and resting.

2.788
The ecology of alder thickets is closely similar to that of aspen stands. The leaf litter produces a very hospitable environment for earthworms and other soil fauna if soil moisture is not excessively high. The high earthworm populations and fairly dense ground cover often provided by young alder thickets furnish excellent woodcock feeding and brooding habitat. Grouse also utilize young alders as cover. The qualitites that attract these two species to alder thickets gradually diminish and eventually almost disappear as the thickets age.

2.789
Hawthorn, crab apple and apple thickets also provide habitat for woodcock and grouse, although the value of these plant species for the two birds may be less consistent and shorter-lived than the values of aspens and alders. Where hawthorns, crab apple and apple occur in pure stands on the study area, they generally are classified as "aged" (closed canopy, few or no ground-level branches, and little cover-producing understory growth). This type of thicket usually indicates land formerly used as pasture.

2.790
Silky dogwood, sometimes growing together with the ecologically similar red-osier dogwood (Cornus stolonifera), apparently is less often associated with high earthworm populations than gray dogwood (Cornus racemosa), which is uncommon on the study area. The dogwoods reduce abundant food and cover for a variety of birds, mainly passerines, and mammals; only gray dogwood is considered to provide good quality feeding habitat for woodcock.

2.791
Meadow, Invaded Meadow and Marsh Ecotypes. Most of the meadows on the study area are abandoned croplands or pastures. The soils generally show some degree of nutrient depletion. Soil moisture ranges from very dry to wet; most of the old fields fall somewhere in the moist to moderately dry range. Typically, the old-field type meadows are dominated by asters (Aster spp.), wild carrot (Daucus carota), cinquefoils (Potentilla sp.), blackberries and dewberries (Rubus spp.), sheep sorrel (Rumex acetosella), goldenrods (Solidago spp.), and various grasses (Danthonia spicata, Panicum spp., Phleum pratense, Poa spp., etc.). The most commonly woody invaders are red maple (Acer rubrum), silky dogwood (Cornus amomum) and quaking aspen (Populus tremuloides). Where invading clumps of aspen, alder or gray dogwood occur woodcock will usually be found. Marshes are highly localized in scattered sites all across the study area. Dominants most commonly are sedges (Carex spp.), common reed (Phragmites communis), smartweeds and tearthumb (Polygonum spp.) bulrushes (Scirpus spp.) and cattails (Typha spp.). Cover of marsh grasses and grass-like plants may be utilized as nesting sites by certain marsh birds.

2.792
Lakeshore Bluff Ecotype. The interface between land and water along the northern margin of the study area consists of a cliff of highly eroded glacial drift and a narrow stony beach. Plant life is very sparse on the cliff face and nonexistent on the beach. There is very little direct utilization of the bluff by animal life, except for the establishment of nesting colonies by bank swallows.

2.793
Cultivated or Grazed Land. Cultivated fields and pastures are communities dominated by one or a very few introduced herbaceous plant species or grapevines, sustained artificially by cultivation or by grazng. Wildlife values of cultivated fields vary with the kind of crop, the agricultural techniques employed and other associated site factors. These areas are of low value to woodcock in their present state.

2.794
Disturbed or Unvegetated Land. Disturbed areas are sites of major past soil disturbances such as raw materials storage and excavation for railroad or road construction. Unvegetated areas are the larger paved or gravelled surfaces and sites currently used for storage of industrial materials. Soils of vegetated disturbed areas are generally somewhat xeric and infertile in character, which make them of low value to woodcock. Resident woodcock habitat can be defined as having the soil characteristics and vegetative cover necessary to attract and hold a breeding population of this particular bird. Flora cover type, soil character and drainage, and food supply are primary habitat factors. Since the woodcock probes with its long bill for its diet of earthworms, suitable soils must be loose and moist and must have a reasonably high organic content. Productive soils are characterized by pH readings in the alkaline or near-alkaline range.

2.795
The vegetative cover on prime resident woodcock habitat consists of an overstory of small trees and large shrubs and an understory of low shrubs, grass and other herbaceous plants. Preferred overstory species are aspens, alders, sweet crab apple, hawthorns, sumac, wild apple and gray dogwood. Understory species indicating prime woodcock habitat are bluegrasses, dewberries, raspberries, goldenrods, wild strawberry, cinquefoils, violets, jewelweeds and asters.

2.796
With few exceptions, the most productive woodcock habitat has an overstory no younger than three to five years and no older than 12 to 20 years.

2.797
Secondary habitat lacks some of the optimum soil and vegetative cover characteristics described for prime habitat. For this reason, the habitat is less productive of woodcock.

2.798
On the Lakefront plant site, secondary habitat may have a lowered productivity or holding capacity for woodcock because: (1) the overstory vegetation is too young or too old, or badly interspersed with tree or shrub species not classified as "prime;" (2) the overstory vegetation invading old fields or open meadows is not old enough or dense enough to provide acceptable cover; (3) soil pH, soil moisture or soil composition are less than optimal for earthworm production or for probing by woodcock.

2.799
Large acreages of old fields on the plant site have been extensively invaded by silky dogwood and red-osier dogwood, species which cannot be listed as prime overstory shrubs. Ordinarily, both indicate habitat which rarely supports resident woodcock, although such areas may be used as "singing" grounds. These areas are important from a behavioral standpoint for breeding and nesting.

2.800
There is also a considerable acreage of land within the boundaries of the plant site which is unproductive habitat for woodcock even though suitable overstory vegetation is present. In almost every one of these cases, the understory indicator plants denoting prime woodcock habitat are missing. Instead, the typical ground plants are poison-ivy, ferns, povertygrass, blackberries, clubmosses, haircap mosses, etc. These areas may however, be important to migrating woodcock during the fall.

2.801
The land lying along the south shore of Lake Erie may represent a unique situation in regard to woodcock migrations. In the spring, the northward-bound birds tend to congregate in suitable coverts along the lakeshore waiting for favorable winds and weather to make the long flight across the lake. Sometimes this waiting period may last a week or more and birds may become unnaturally concentrated on shoreline areas. Any protective cover may be utilized, including types not typically occupied by resident woodcock such as hardwood forests, invaded meadows, etc.

2.802
A reverse situation may occur in the fall. Birds may congregate for days on the Canadian side and then fly across by the hundreds or even thousands during the first favorable night. Presumably they would be sufficiently tired when they reach the southern shore to drop into the first available cover. This again could create a high concentration temporarily and could result in many birds resting in atypical cover. Geographic location alone may greatly increase the overall value of lakefront habitat.

2.803
Resident woodcock habitat on the total U.S. Steel Corporation lakefront property was surveyed in 1978, using both aerial infrared photo imagery analysis and ground investigation. Land classified as [illegible] woodcock feeding habitat makes up approximately 102 hectares [illegible] as shown in Figure 2-140. Typical woodcock feeding [illegible] to be confused with total woodcock habitat. Habitat [illegible] and cover, and possibly other components such [illegible] behavioral needs. The total habitat area [illegible] than any single component.

2.804
Wildlife biologists recognize that it is almost impossible to arrive at an exact population figure for any large unit of woodcock habitat. This is particularly true of the U.S. Steel Corporation's lakefront property, since populations fluctuate widely in relation to season and to the amount of rainfall. There is even a day-to-day fluctuation during early spring (March and April) and fall (October and November).

2.805
Liscinsky (1972) also presented data on censused singing male woodcock in Pennsylvania for eight breeding seasons from 1953 through 1961. Censuses of singing makes are considered as fairly reliable indexes of relative breeding populations between different sites and different years. The mean of the Pennsylvania Statewide averages for the eight years was 5.4 singing birds per census route in recognized woodcock habitat.

2.806
Woodcock studies in various parts of the range also have shown that the average reproductive increment in one season is 1.8 offspring per breeding female.

2.807
Censuses of singing males were made during the breeding seasons of 1977 and 1978 by Pennsylvania Game Commission personnel on a portion of the lakefront area. Counts along the three routes were nearly identical both years. Using the 1977 figures, assuming a 150-meter (164-yard) hearing radius in order to adjust for a slight overlap in coverage between the three routes, the average count per route was 15.3 singing birds.

2.808
On the basis of these figures, it might be plausible to estimate the resident populations in the following manner.

2.809
The 1977 census of singing males on the lakefront area produced an adjusted average of 15.3 birds per route; the 1953-1961 Pennsylvania Statewide average census of singing birds per route was 5.4. It might be reasonable to assume that the lakefront area supports 15.3/5.4, or 2.8, times the Statewide average population density of this species.

2.810
The Pennsylvania Statewide average population density was estimated by Liscinsky (1972) to be approximately one bird per 20 hectares (50 acres) in spring across large units (on the order of several square

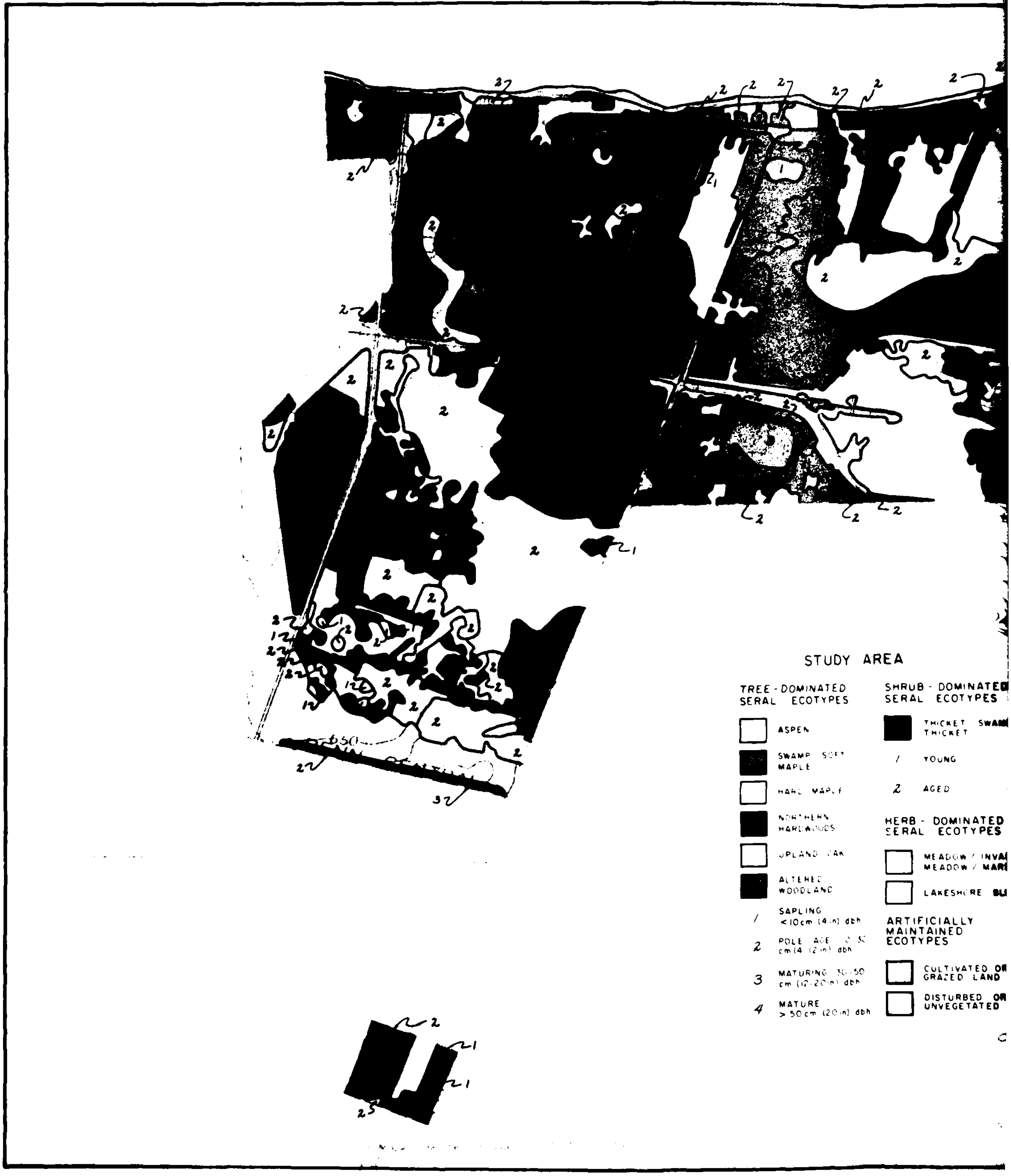
miles) of recognized habitat. One bird per 20 hectares (50 acres) multiplied by the local census increment of 2.8 yields a density estimate of 2.8 birds per 20 hectares (50 acres) or approximately one bird per seven hectares (18 acres) in spring for the lakefront area.

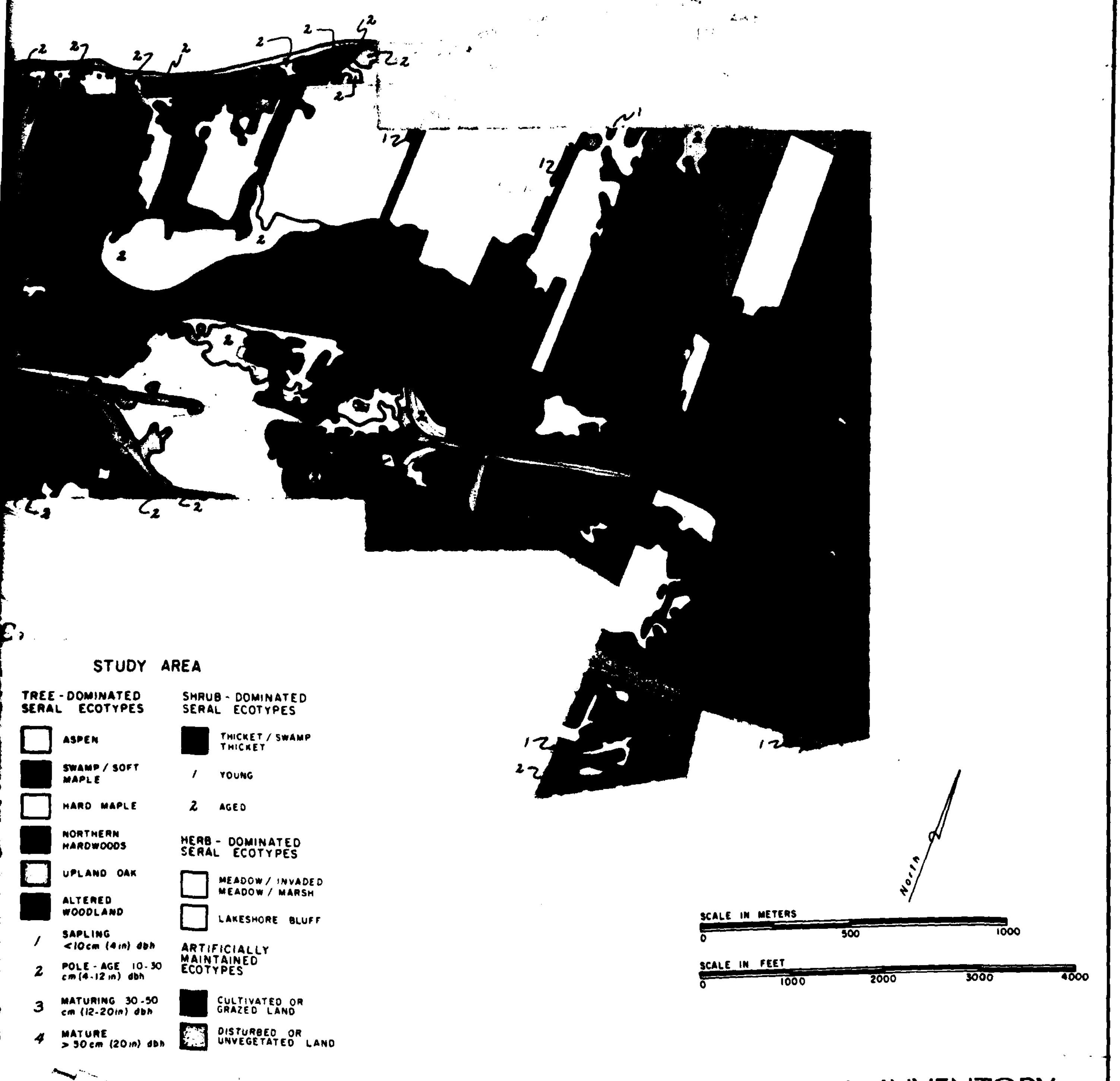
2.811
The undeveloped portion of the U.S. Steel Corporation's property north of U.S. Route 20 comprises 1,827 hectares (4,547 acres) or 18 square kilometers (seven square miles). The assumption is made that the distribution of land identified during a preliminary ground and aerial photomap survey as typical resident woodcock feeding habitat should approximate the distribution of the estimated resident population. The results are as follows:

	Estimated Spring Resident Woodcock Population	Est'd Existing Typical Resident Woodcock Feeding Habitat	Potential Woodcock Management Area
715-hectare (1,766-acre) Proposed Plant Construction Area	107	43 hectares (107 acres)	--
456-hectare (1,127-acre) Proposed Wildlife Mitigation Area	57	23 hectares (57 acres)	270 hectares (693 acres)

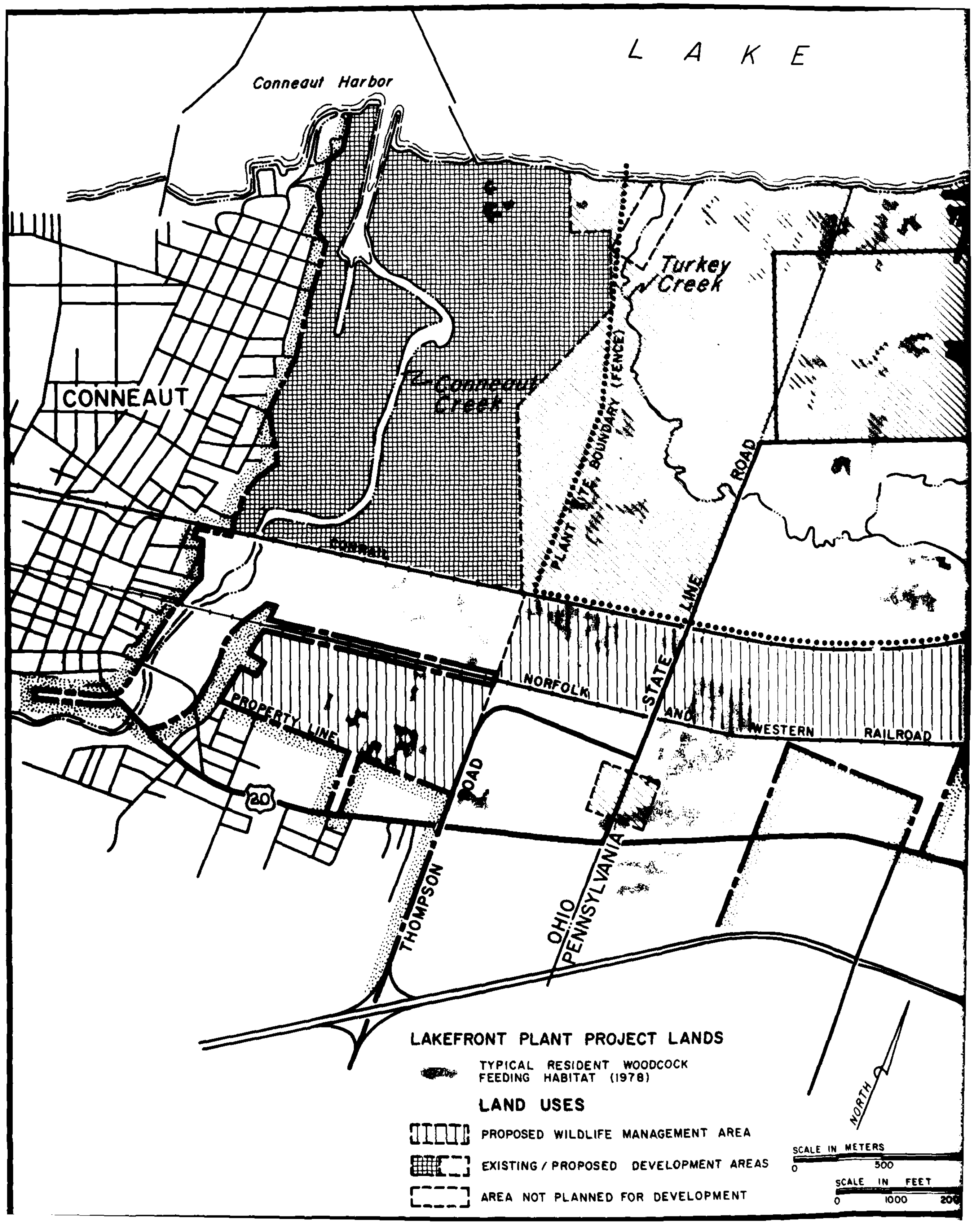
The applicant considers these figures to be exceptionally high in comparison to populations across the total range of this species. However, as pointed out by the Pennsylvania Game Commission the 1953-1961 Statewide average of 5.4 birds per route and the estimated density developed by Liscinsky (1972) of one bird per 50 acres may no longer be accurate for estimating populations at this later date. The State-wide census in recent years has run as low as 0.78 birds per route.

2.812
The Pennsylvania Game Commission collected data along three woodcock singing ground survey routes on the U.S. Steel proposed Lakefront Plant site during 1977 and 1978. The first step in calculating the resident woodcock population was to determine the number of resident adult males. This was done based on the 0.2 mile of stop spacing of the survey routes. A grid on this spacing was placed on a map of the area (Figure 2-141). It showed 113 grid points fell within the Pennsylvania segment of the U.S. Steel property. Multiplying this number by 1.46 birds per stop gave a spring resident male population of 165. Although woodcock are polygamous and females slightly outnumber males in the spring, it was assumed the female spring population was equal to the number of males. Thus, the resident spring

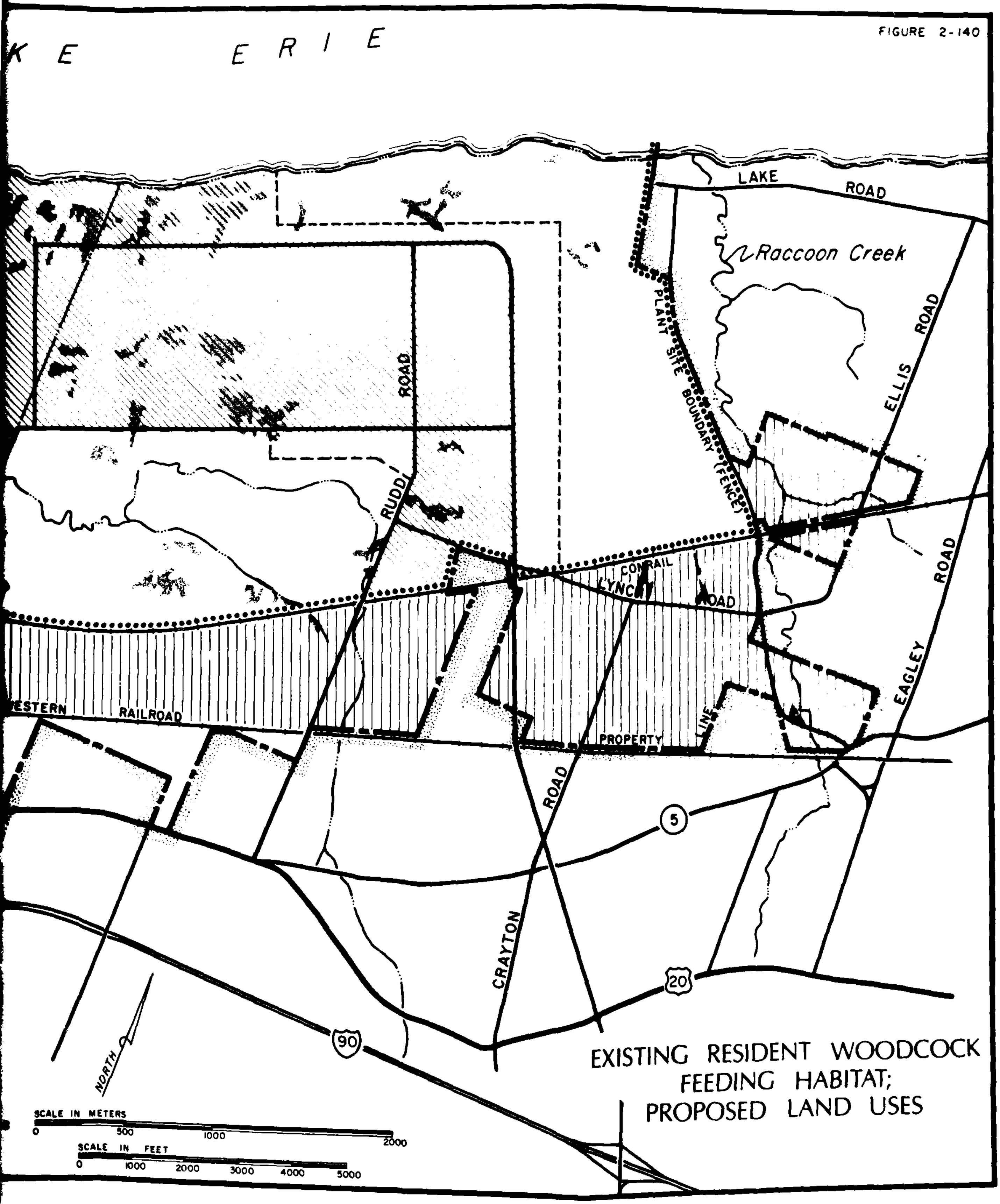

STUDY AREA
TREE-DOMINATED SERAL ECOTYPES
ASPEN
SWAMP SOFT MAPLE
HARD MAPLE
NORTHERN HARDWOODS
UPLAND OAK
ALTERED WOODLAND
1 SAPLING <10cm (4 in) dbh
2 POLE AGE
3 MATURING 30-50 cm (12-20 in) dbh
4 MATURE >50 cm (20 in) dbh
SHRUB-DOMINATED SERAL ECOTYPES
THICKET
1 YOUNG
2 AGED
HERB-DOMINATED SERAL ECOTYPES
LAKESHORE
ARTIFICIALLY MAINTAINED ECOTYPES
CULTIVATED OR GRAZED LAND
DISTURBED OR UNVEGETATED



ECOLOGICAL INVENTORY OF PRIMARY IMPACT AREA



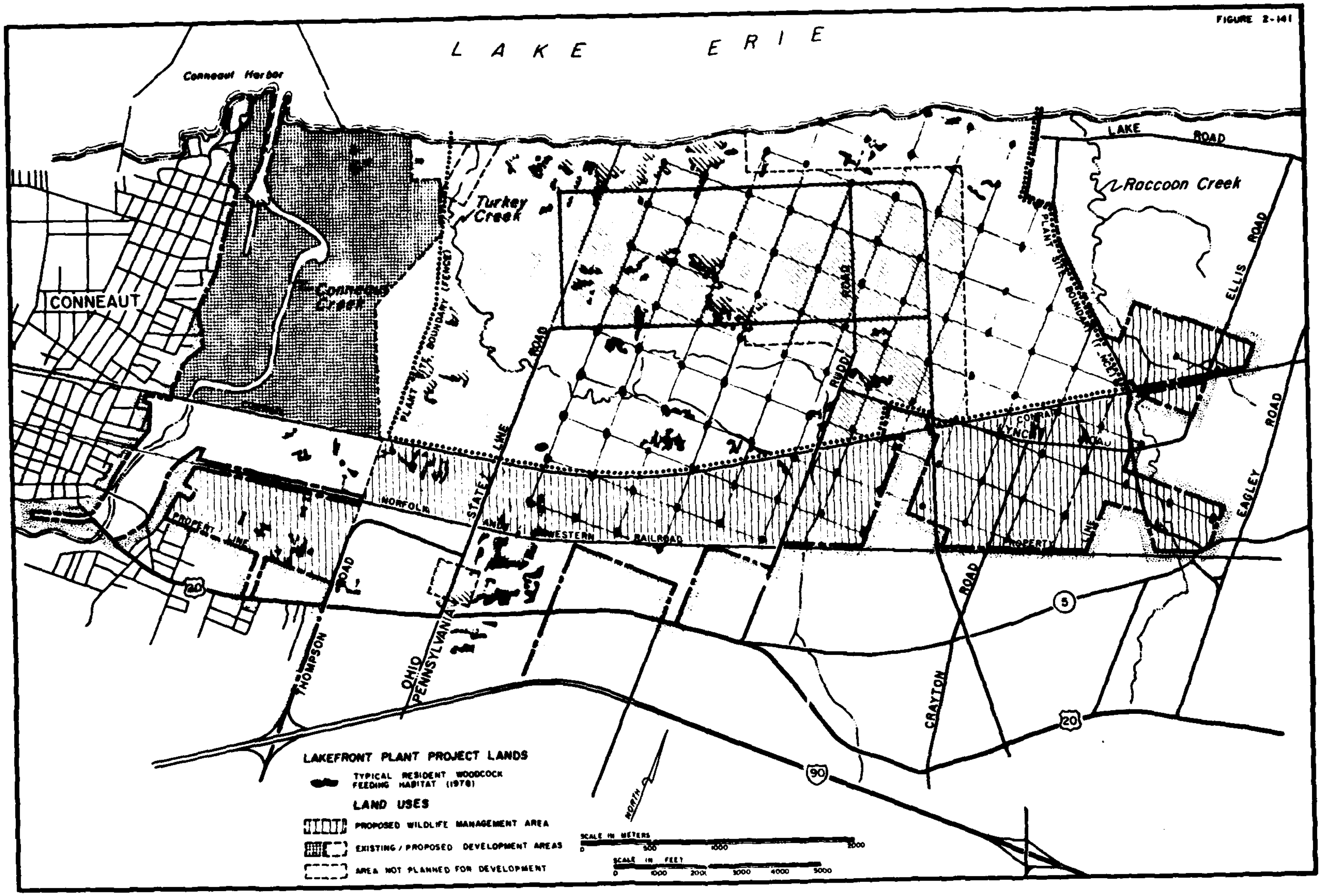
LAKE
Conneaut Harbor
Turkey Creek
Conneaut Creek
CONNEAUT
CONRAIL
PLANT SITE BOUNDARY (FENCE)
STATE LINE ROAD
NORFOLK AND WESTERN RAILROAD
PROPERTY LINE
20
THOMPSON ROAD
OHIO
PENNSYLVANIA
NORTH
LAKEFRONT PLANT PROJECT LANDS
TYPICAL RESIDENT WOODCOCK FEEDING HABITAT (1978)
LAND USES
PROPOSED WILDLIFE MANAGEMENT AREA
EXISTING / PROPOSED DEVELOPMENT AREAS
AREA NOT PLANNED FOR DEVELOPMENT
SCALE IN METERS
0
500
SCALE IN FEET
0
1000



EXISTING RESIDENT WOODCOCK FEEDING HABITAT; PROPOSED LAND USES

Figure 2-141

Grid used to determine Resident Male Woodcock Population on the Lakefront Plant site by Pennsylvania Game Commission



breeding population was calculated to be 330. Information from Pennsylvania woodcock research investigations (Liscinsky, 1972) and hunter survey data compiled by the Fish and Wildlife Service (Tautin, 1978) was used to calculate reproduction and resident woodcock survival to fall.

Young hatched = adult females (165) X 1.85 young hatched per female = 305.

Young surviving to fall = young hatched (305) - 25 percent mortality (76) = 229.

Adults surviving to fall = spring population (330) - 17 percent mortality (56) = 274.

Total fall population for the Pennsylvania segment of U.S. Steel property = 274 + 229 = 503.

Woodcock populations for the plant construction area and the remaining undisturbed areas were estimated. The population distribution of resident birds was calculated by the amount of woodcock habitat present in each. (Refer to Figure 2.141 and the table below).

TABLE 2-401

Woodcock Habitat Distribution

Segment	Acres Habitat	Percent Habitat
Plant Construction Areas	399	31.4
Turkey Creek Greenbelt	406	31.9
Eastern Greenbelt	199	15.7
Management Area	267	21.0

Resident woodcock distribution was then determined as follows:

Resident Woodcock Population - Fall

Segment	Birds
Plant Construction Area	158
Turkey Creek Greenbelt	160
Eastern Greenbelt	79
Mangement Area	106

TABLE 2-401 (Cont'd)

Resident Woodcock Population - Annual Segment	Birds
Plant Construction Area	199
Turkey Creek Greenbelt	203
Eastern Greenbelt	100
Management Area	133

Source: *Pennsylvania Game Commission*

2.813
A comparison of the applicants population estimate and the Pennsylvania Game Commission estimate for the Plant Construction Area only, can be made at this time.

Applicant's Estimate
Fahringer, McCarty, Grey, Inc.
Estimated Spring Resident Woodcock population to be 107

Young hatched = adult females 53.2 X $^{t}1.85$ = 98.98
total young surviving to fall = 98.98 X $^{*}.25$ = 74.24

Adult total surviving to fall = 107 X $^{*}.17$ = 88.81
total fall population for construction area
only = young survivals 74.24
adult survivals 88.81
total 163.05 birds

*= mortality
^{t}= natality

Pennsylvania Game Commission Estimates
The fall population for the construction area was calculated to be 158 birds (See table above - Resident Woodcock Population Distribution - Fall Segment).

Comparison of Results
Of the total 1,766 acres required for the construction site, 57 percent is located within the Pennsylvania boundary. By adjusting the Fahringer, McCarty, Grey, Inc. total population by 57 percent, the difference can be calculated as follows:

.57 X 163 = 93 birds for the Pennsylvania portion.

93 Fahringer, McCarty, Grey, Inc. Estimate
158 Pennsylvania Game Commission estimate = 59 percent

The difference between the two estimates is approximately 40 percent. This is considered to be a reasonably close agreement in the view of the state of the art for calculation of wildlife populations. Wildlife populations are extremely difficult to estimate. Measurements of habitat quality and quantity are considerably more important than estimated populations number and should be given greater value.

2.814
Deer (Odocoileus virginiana)
Deer have been observed on numerous occasions and their tracks recorded at nearly every sampling area within the proposed Lakefront site. The greatest number of deer was observed in the area between State Line Road and Rudd Road, although frequent sightings have occurred along Childs Road, the Conrail tracks, and at the Perry Bluff ore storage area. Although adults were encountered most frequently, fawn were also observed indicating successful reproduction within the resident population. Evidence of heavy browing was noted during early spring in the silky dogwood and hawthorn stands of Study Area No. 9 and also in the area east of the Study Area No. 8. The whitetail deer is a vegetarian and generally prefers a diet of trees, shrubs, weeds, and grasses. Within the Lakefront site such food sources include hawthorn, dogwood, sumac, cinquefoils, clover, plantain, sweet clover, crowsfoot, dandelions, and violets. Generally, the study areas exhibiting the most favorable habitat for deer are Nos. 2, 4, 5, and 9. Officials of the Pennsylvania Game Commission and game protectors from both States estimate the total deer population of the Lakefront Site at 150-200 individuals. In fact, one resident reported seeing 55 deer at a single water-hole during the fall of 1976. At this time, accurate approximations of the on-site deer population are not available.

2.815
Eastern Cottontail Rabbit (Sylvilagus floridanus)
The number of eastern cottontail rabbits observed on the site was found to be low during the months of April and May, but much higher during the month of June. Generally, this species was encountered most frequently along Lake Road in areas where woodlands and open fields join, in the old fields adjacent to Rudd Road, near the southern terminus of Elmwood Road and also along Lynch, Childs, and State Line Road. Wildlife biologists of the Pennsylvania Game Commission estimated the rabbit population of the Lakefront site at one individual per two acres of suitable habitat.

2.816

Beaver (Castor canadensis)

During the site survey beaver were never actually observed although evidence of their occupation was noted on a tributary to Turkey Creek. However, based on the size of the dams observed, the condition of the beaver lodge and the sparse evidence of feeding it is reasonable to assume that this population is very small.

2.817a

Fox (Family canidae)

Both the red fox (Vulpes vulpes) and the gray fox (Urocyon cinereoargenteus) have been observed on the Lakefront site and their existence has been verified by Game Protectors from Ohio and Pennsylvania. A den with several openings was located in vegetation Study Area No. 4. During the early spring of 1977 five pups were observed near a den in the vicinity of Study Area No. 8. A similar type of den was also encountered at Study Site No. 7. Both species of fox have similar diets which vary with the season. Although they prey on meadow voles and rabbits when available, they also feed on fruits such as blueberry, raspberry, wild cherry, apple, and grape.

2.817b

Fox Squirrel (Sciurus niger)--This squirrel was sighted in the treetops of Area 3 and Area 7, and on the ground near Elmwood Road. Sightings were made in spring, summer, and fall. This species prefers open woods, often bordering agricultural fields, and eats fruits and buds of oaks, elms, maples, and wild cherry as well as insects.

2.817c

Ruffed Grouse (Bonasa umbellus)--The ruffed grouse is mentioned as a principal game species in Ashtabula County on page 2-946. It is common on the site as a permanent resident, nesting in open woods or wood edges.

2.818

Future Biotic Trends

If the lakefront site experienced no further human disturbance, it would continue to be an important wildlife area. However, the succession of bushy shrubs to sapling tree communities will gradually reduce the attractiveness of habitat for such species as the woodcock, deer, and rabbit although it will improve for such species as the gray fox and opossum. The natural succession of lakefront site vegetation will ultimately climax with the establishment of a beech-maple forest unless natural events or future development offset the process.

Aquatic Biota

Lake Erie: Central Basin

2.819
Numerous reports have documented the deterioration in Lake Erie water quality since 1850 and subsequent effects on floral and faunal composition. Major impacts from the early clearing of the majority of woodlands and drainage of some swampland for farming have included increased sediment and nutrient loads in the lake through runoff. (2-230) Rapid growth of major industrialized cities, especially along the Detroit River and the mouths of tributaries to the Western Basin and southwestern portions of the Central Basin, have added considerably to the increased nutrient and pollutant loading in the lake. The overall effect has been an increase in the rate of entry of anthropogenic materials as well as in their total concentrations in the lake. Examples include:

A threefold increase in the sedimentation rate over the last century (at least 30 million tons of inorganic sediments from shore and watershed erosion are added annually),

Over a 66 percent increase in the concentration of total dissolved solids in the last 50 years,

A quadrupling of chloride concentrations during the first 60 years of this century,

A doubling of sulfate concentrations during the first 60 years of this century,

The tripling of total nitrogen between 1930 and 1958,

A thirteenfold increase in open lake ammonia between 1942 and 1967,

An estimated fourfold increase in soluble reactive phosphorous for the period between 1942 and 1967, and

Increases in mercury, lead, zinc, cadmium, and copper. (2-231, 232)

It is generally acknowledged that the near 2°F increase in the annual mean water temperature due to climatic warming (2-233) and the shallowness of Lake Erie have contributed to the observed biological effects at othr cultural contributions to decreasing water quality Studies have indicated a gradient of decreasing concentrations of nutrients from west to east, and from the southern shore of the lake

to mid-lake. The Western Basin, smallest and shallowest of the three basins, has the highest concentrations of nutrients. Its shallowness allows for near continual mixing of the water column with short periods of thermal stratification during calm, hot spells.

2.820
Sediment oxygen demands were sufficient to deplete the oxygen supply of hypolimnetic waters during an unusually long 28-day period of thermal stratification in 1953, practically destroying Hexagenia populations. (2-230) With increased nutrient loading and subsequent recurrences of oxygen depletion, this once dominant benthic species has been replaced by the more facultative chironomids and oligochaetes. Not only has the Eastern Basin received the lower concentrations of nutrients, but its depth is sufficient for cool oxygenated waters to support species such as the decapod, Mysis relicta, and the amphipod Pontoporeia affinis, and populations of coldwater fishes. (2-230) However, decreases in oxygen levels have been observed here as well. (2-231) The moderate depth of the Central Basin has created a slightly different set of problems. Thermal stratification creates a thick epilimnion (15-20 meters) and a relatively thin hypolimnion (3-5 meters). (2-231) Sediment oxygen demands are sufficient to cause oxygen depletion in hypolimnetic waters and increasing areas of anoxic hypolimnion (less than 0.5 ppm O_2) have been recorded since 1930. (2-231) From 1973 to 1975 the percentage of area of Central Basin hypolimnion that became anoxic decreased from 93 percent to four percent. (2-231) This was probably because the hypolimnion of the basin was 2.25°C cooler, and was 1.5 meters thicker than in 1974, due to reduced spring wind stress. This increased volume of water would take longer to become anoxic. (2-231) The reported increase in area of anoxic hypolimnion to 63 percent in 1976 and 74 percent in 1977 would seem to bear out this hypothesis. Under anoxic conditions, soluble reactive phosphorus is regenerated from nutrient rich sediments, and then becomes available for algae uptake after turnover. The possible importance of this form of phosphorous addition can be seen from the fact that 22 percent less soluble reactive phosphorus was measured at one Central Basin station after turnover in 1975 than in 1974. (2-231) Furthermore, total phosphorus did not show a large increase in the hypolimnion in 1975. (2-231) Other factors, including the amount of light, turbidity, and nitrate availability will moderate the degree to which this will affect algae populations. The changes in Central Basin water quality (and in the other two basins) have altered the quantity and type of organisms, at all trophic levels, that now inhabit this section of Lake Erie.

a) Benthos

2.821
Benthic macroinvertebrates are relatively sessile organisms. The species compositions of these populations are frequently cited as

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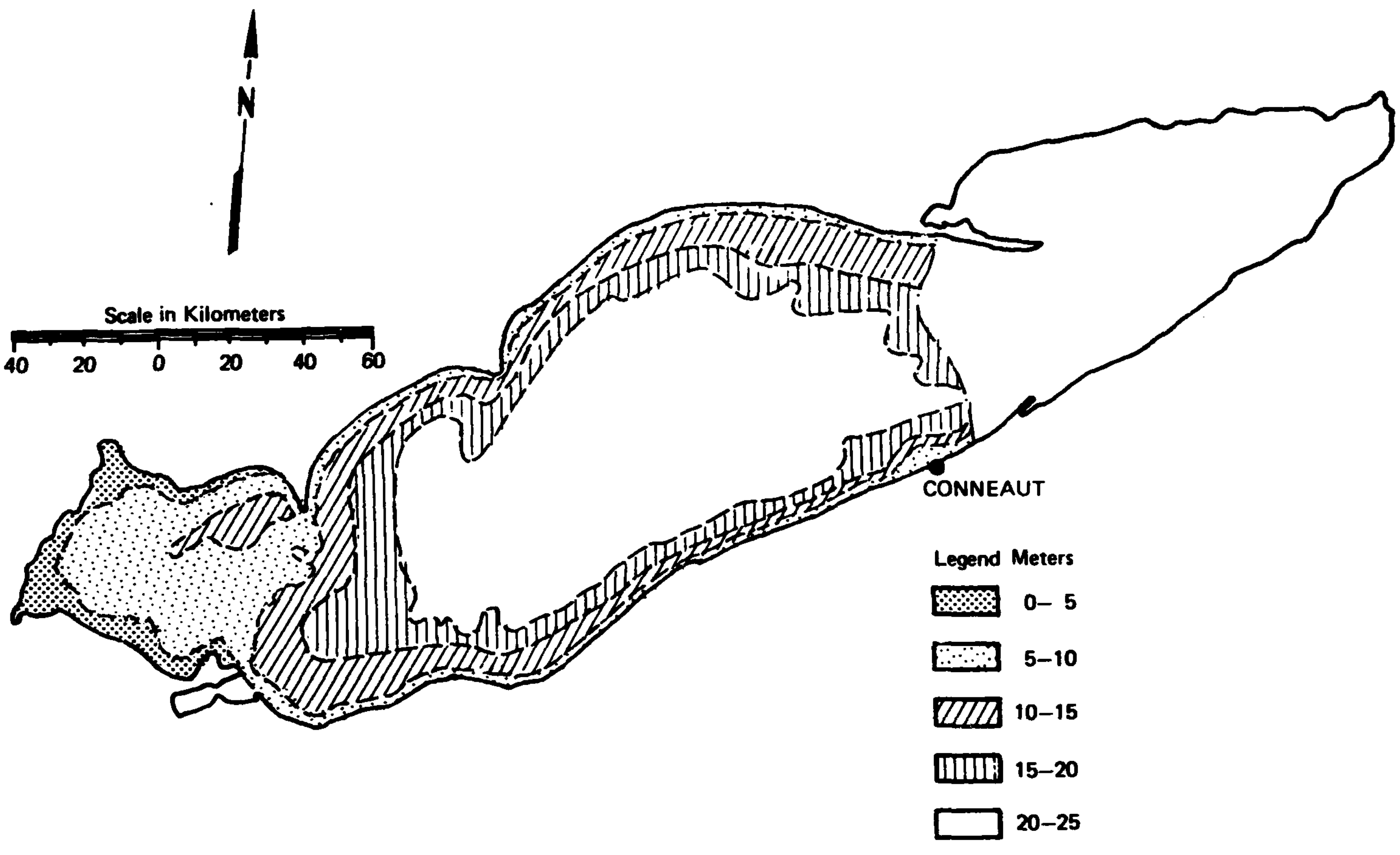
indicators of water quality, as different species can reflect sensitivity to sediment loading, increased turbidity, and changes in DO levels, among others. Long-term historical data for Central Basin bottom fauna is not available. The U. S. Public Health Service (1968) conducted several surveys and observed a predominance of facultative species such as Tubificidae, Tendipedidae, Sphaeriidae, and nematodes, especially in the western portions of the basin. The eastern portions of the Central Basin contained populations of Isopoda, Hiurudinea, Prosobranchia and amphipods as well, with these latter populations becoming more significant in the far eastern sections. As illustrated in Figures 2-142 and 2-143, a large portion of the Central Basin has either a mud, mud/sand bottom, or clay, till/sand bottom. The southern shore is either shale bedrock or sand and gravel. (2-231) These substrates, in combination with anoxic hypolimnetic conditions, affect benthos distribution. According to the Center for Lake Erie Research (CLEAR) survey, Tubificidae are the most abundant oligochaetes in the Central Basin, with the dominant *Peloscolex ferox* found throughout and *P. multisetosies* concentrated in midlake regions. Several species of *Limnodrilus* are also found throughout the basin. *Potamothrix moldaviensis* and *Tubifex tubifex* are found along the margins of both basins with the latter being more abundant in the western section. (2-231) The molluscs were also important in the benthic fauna, with the fingernail clams (Sphaeriidae) being represented most frequently and occurring throughout the basin. Most gastropods found were prosobranch varieties (internal gill) and were either limited to a narrow band along the southern shores of the basin, or absent from midlake regions. Unionid clams were frequently found in the basin. The Chironomidae were third in importance and *Chironomus plumosus* and *Procladius* were the most abundant occurring over most of the basin. (2-231) Hiurudinea and *Gammarus fasciatus* were found along the coastal shore of the basin and *Asellus r. racouitzai* was found in the far eastern sector. *Mysis relicta*, requiring cold, well oxygenated water, was found in one offshore location in the eastern sector of the Central Basin. (2-231)

b) Phytoplankton

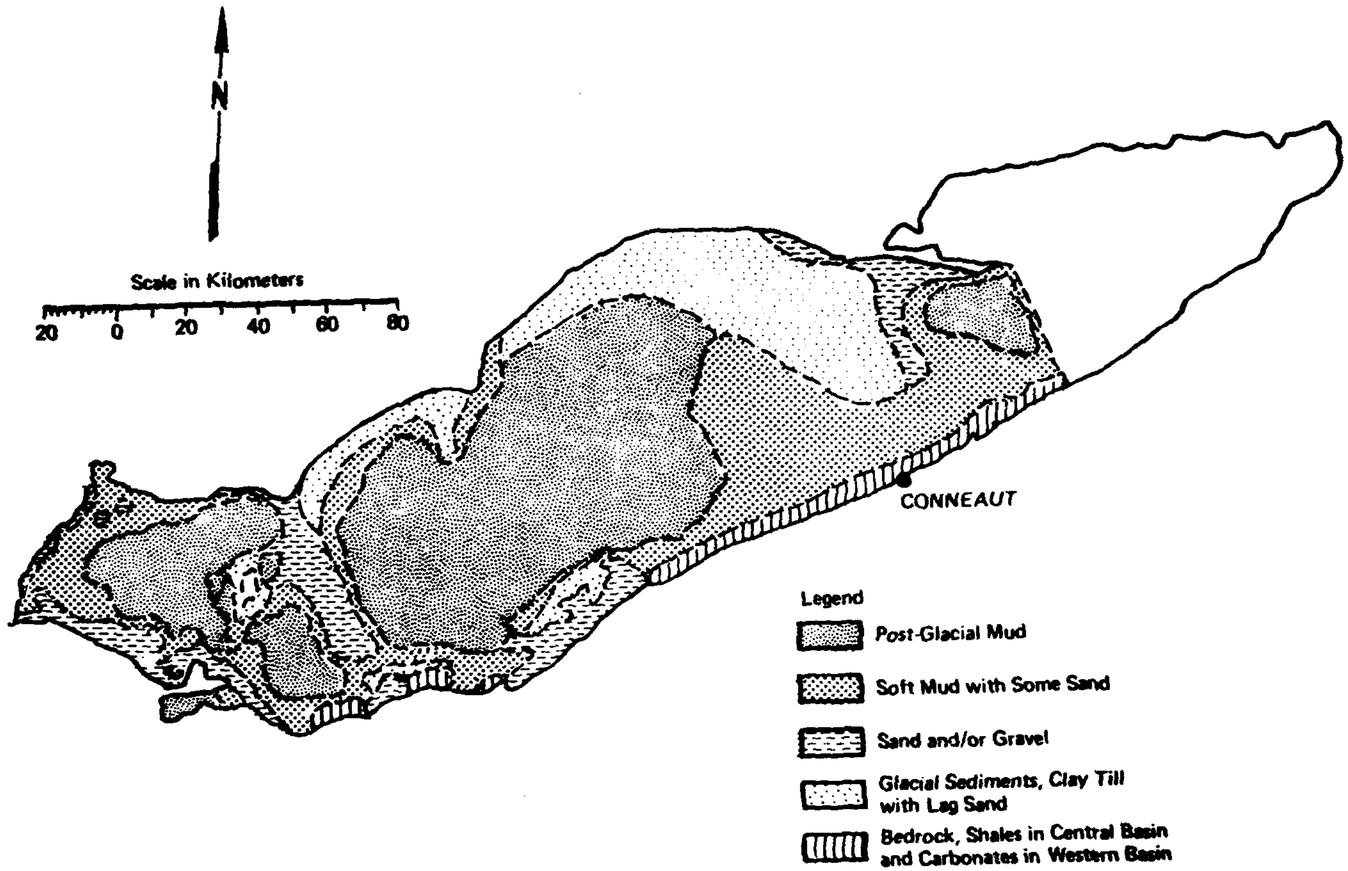
2.822
Due to varying methodologies, limited sampling periods and/or locations, historical information on phytoplankton populations are difficult to use for characterizing Central Basin populations and trends over the last 50 years. The following generalizations can be made:

There is a decrease in density of algae populations from west to east.



Source: Modified from CLEAR Technical Report No. 59, January 1971.

FIGURE 2–142 LAKE ERIE BATHYMETRY (CENTRAL AND WESTERN BASINS)



Source: Modified from CLEAR Technical Report No. 59, January 1971.

FIGURE 2–143 DISTRIBUTION OF SURFICIAL SEDIMENTS (LAKE ERIE CENTRAL AND WESTERN BASINS)

There are vernal and fall pulses, with diatoms representing the dominant populations, especially in the spring.

At least in the nearshore areas, green and blue-green algae are important during the summer and fall, but never become the dominant group.

In the Cleveland area, by 1964 the major spring diatom had become Melosira instead of Asterionella, which predominated earlier studies. The fall pulse had become a mixed dominance of Melosira and Fragilaria, but also included a number of blue-green algae.

Seasonal cycles of abundance in the Central Basin have changed so that spring and fall maxima are not only several times higher, but occur for longer durations. Available phytoplankton biomass for subsequent trophic levels may be at least 20 times higher than in the 1920s.

Growth of the nuisance filamentous algae Cladophora glomerata, to depths as great as five meters around the western islands and along shorelines, have frequently become heavy in the last 30 years. (2-231, 232)

A survey of chlorophyll concentration distributions in the Western and Central Basins from 1973-1975 illustrates the "west-east" and "south-north" gradients in algae population density mentioned above. Yearly averages of corrected chlorophyll a, (volume weighted concentrations) from various locations in the Western and Central Basins are given below:

Chlorophyll a Averages in Lake Erie

	1973	1974	1975
Western Basin	12.05 ug/l	13.45 ug/l	14.80 ug/l
Central Basin Sandusky Area	6.55 ug/l	9.08 ug/l	9.77 ug/l
Central Basin Shore Areas	5.40 ug/l	4.52 ug/l	6.71 ug/l
Central Basin Mid-Lake	3.60 g/l	3.30 g/l	5.08 g/l

SOURCE: Modified from CLEAR Technical Report No. 59, 1977.

In the Central Basin, higher chlorophyll a concentrations were seen in early May and late October in 1974, and in March/April and early October in 1975. The fall peak concentrations following turnover were approximately twice those of the spring concentrations, which reflect spring runoff. (2-231) Furthermore, these data represent a significant increase in chlorophyll a values over a 1967 study and, to a lesser extent, a 1970 study. (2-231)

c) Zooplankton

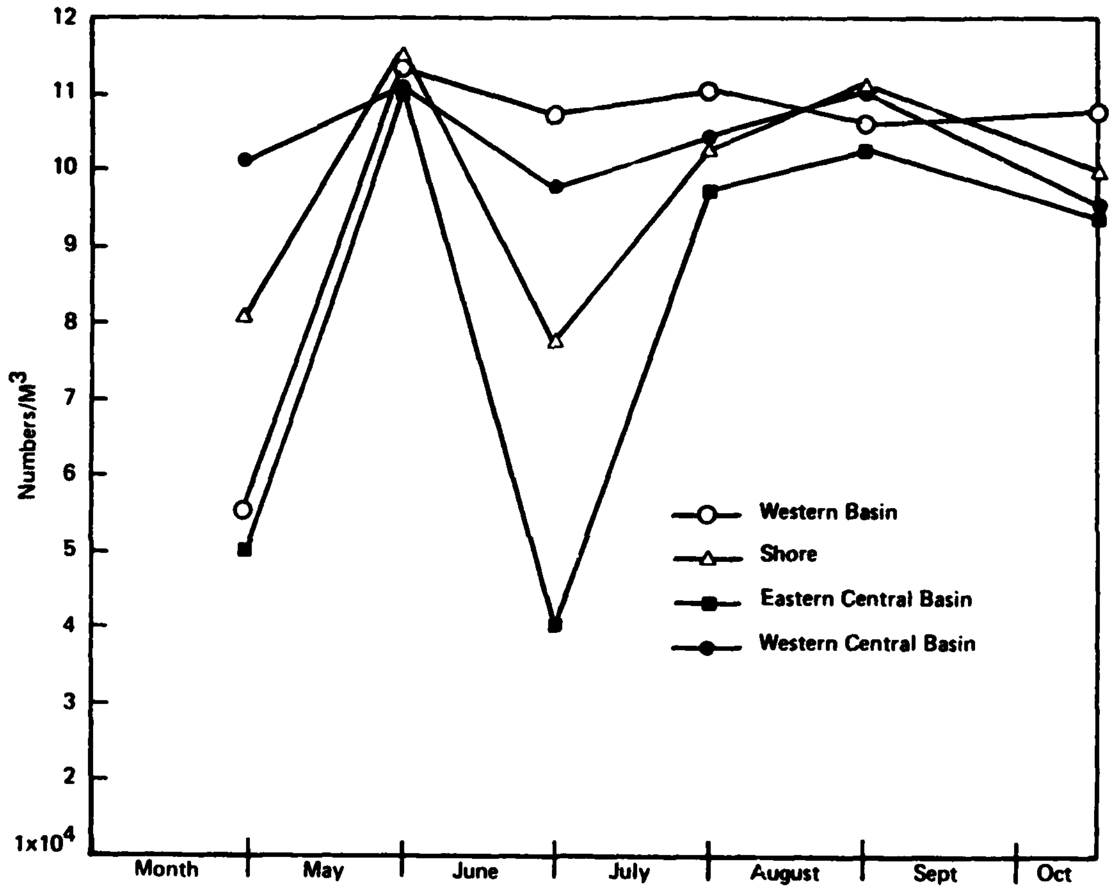
2.823
Lake Erie historical data on zooplankton populations are difficult to use in illustrating trends because of variations in sampling technique, scope, season and frequency of effort. (2-231) The CLEAR survey compared the number of zooplankton found in the Western Basin, shore areas, and western and eastern sections of the Central Basin. Some of the 1974 results are noted in Figure 2-144. The most common rotifers found during the spring sampling period were Notholca, with Keratella and Polyarthra species becoming more common later in the season. Population peaks occurred in June and August. (2-232) Cladoceran populations were highest near shorelines, and numbers peaked in June and September. Bosmina longirostris, Eubosmina coregoni, Daphnia retrocurva, Daphnia galeata mendotae, Daphnia lomgiremis were abundant in both basins. Chyodorus sphaericus, considered a eutropthic indicator species, occurred throughout the Central Basin by late October. (2-231) Engel (1962), Bradshaw (1964), Watson (1974) have all reported increases in populations of cladocerans since 1939. (2-231) Cyclops bicuspidatus thomasi was the most abundant spring cyclopoid in the Central Basin. These were replaced by Mesocyclops edax, Cyclops vernalis, and Tropocyclops prasinus mexicanus later in the season. Diaptomus oregonesis and D. ashlandii were the most abundant calanoid species. (2-231) As stated in the CLEAR study, identification of the specific trophic niche of zooplankton in Lake Erie has not been established. Williams (1966) felt that rotifer abundance correlated with phytoplankton abundance, where Patalas (1972) felt that crustacean abundance was related to particulate phosphorous loading rates. Glooshenko, et al. (2-231) described the Lake Erie zooplankton food chain as being detrital and that there was no correlation with chlorophyll a or pheopigment concentrations. Changes in Lake Erie water quality and the composition of predator populations may have been responsible for the decline and/or disappearance of some of the larger species of zooplankers as reported by Gannon and Berton. (2-234) Limnocalanus marcrurus sars is a large species of copepod that migrates to cooler hypolimnetic waters during summer months. Oxygen depletion of these waters may have contributed to its decline. Other large zooplankers such as Daphnia pulex, Diaptomus sicilis and Epischura lacustris have

also declined lakewide. Simultaneously, there has been a decline in the abundance of large piscivores, with obligate planktivores such as the smelt, alewife, white bass, and yellow perch becoming abundant. Stomach analysis of smelt in 1958 showed selective feeding for large Limnocalanus.

d) Fish

2.824
Due to their commercial and recreational significance, changes in fish populations have been the most widely documented. Van Meter and Trautman (2-235) listed 138 species of ichthyofauna that have been reported in Lake Erie at one time or another. A selected list of past and present fish species of recreational and commercial importance are presented in in Table 2-402. Typical spawning season, and habitat of adults as well common habitat and food types of the other stages in the life history of these fishes have been included The major depth contours in the lake and the distribution of surficial sediments, may be consulted and related to habitat preferences of the various fish species. These are illustrated in Figures 2-143 and 2-144, respectively. Commercial fish production can be used as an indicator of species abundance, recognizing the fact that variations in fishing gear, and selectivity in effort and reporting all effect such statistics. Although production has not changed significantly since the 1870's, these data indicate the content of catches has changed dramatically (refer to Table 2-403). There has been progressive loss of high value species such as lake herring, sauger, whitefish, blue pike, and more recently walleye, with replacements by less valuable species such as yellow perch, smelt, freshwater drum, and white bass. Heavy selective fishing pressure has been a causative factor, but this has probably been compounded by environmental stresses including: hundreds of dams that block spawning tributaries; increased siltation that covered or eliminated beds of inshore rooted aquatics; increased nutrients and lowered water quality, including poor oxygen levels in the Western Basin and persistent anoxia in the Central Basin; and decreasing transparency in the water column (2-32). Increases in mean lake temperature and the successful establishment of competitive introduced species must also have played a role.

2.825
The importance of shallow bays, sandy shallows, shoals and tributaries as spawning grounds for most of these listed species is illustrated in Table 2-402. Figures 2-142 and 2-143 show that in Lake Erie, such suitable shallow areas are located in the Western Basin, the divisions between the three basins, and the shorelines. Decreased in vegetated shallows and accessible tributaries which are



Modified from: CLEAR Technical Report No. 59, January, 1971.

FIGURE 2–144 AVERAGE ZOOPLANKTON POPULATIONS IN THE WESTERN BASIN AND SECTIONS OF THE CENTRAL BASIN DURING 1974 SAMPLING

Table 2-402

Selected Species of Lake Erie Fishes [Spawning, Habitat, and Food Types][1]

		Spawning		Fry/Immatures		Adults		
	Introduced Species	Season	Typical* Habitat**	Typical* Habitat**	Common Food Type***	Typical* Habitat**	Common Food Type***	Notes
Sea Lamprey (Petromyzon marinus)	X	Jun-Jul	1,A	4,A	U	B,(I)	R	[illegible] years as ammocoetes
Lake Sturgeon (Acipenser fulvescens)		May-Jun	8,3,7,H,(A)	G	Z	C & G	Z	Sexual maturity around 20 years
Alewife (Alosa pseudoharengus)	X	Apr-Jul	1,E,7	E,G	V	C,(I)	V	May move inshore to feed
Gizzard Shad (Dorosoma cepedianum)	X	Jun-Jul,May[2]	1,2,E	7	U	B	T	Northern edge of its range
Coho Salmon (Oncorhynchus kisutch)	X	Sep-Nov	1,8,A	A	V,W,X	B,(I)	Y	Probably no natural reproduction in Lake Erie
Chinook Salmon (Oncorhynchus tshawytscha)	X	Sep-Oct	1,8,A	A	S,V	B,(I)	Y	Probably no natural reproduction in Lake Erie
Rainbow/Steelhead Trout (Salmo gairdneri)	X	Apr-Jun	1,8,A	A or B	S,V,W	B,(I)	S,V,W,Y	Possible natural reproduction in Lake Erie
Brown Trout (Salmo trutta)	X	Oct-Nov	1,A	A or B	S,W	B,(I)	S,W,Y	Possible natural reproduction in Lake Erie
Lake Trout (Salvelinus namaycush)		Oct-Dec	2,D	B,D	V	B,C	V,Y	Below thermocline in summer
Lake Herring/Cisco (Coregonus artedii)		Nov-Dec	1,E	E	T,V	B	V	Below thermocline in summer
Lake Whitefish (Coregonus clupeaformis)		Nov-Dec	1,E,(A)[3]	7,6	V,W	B,C or G	V,W	Below thermocline in summer
Rainbow Smelt (Osmerus mordax)	X	Mar-May	1,F,G,(A)	F	W,(V)[4]	B,(I)	W,(V)[4](Y)[5]	Stay away from light, adults are in deeper water in the summer[5]
Northern Pike (Esox lucius)		Apr-May	5,E,A, or B	E	V,X	B	Y,(V)[3]	
Muskellunge (Esox masquinongy)		Apr-May	5,E,B	B,E	V,X	B,F	Y	
Goldfish (Carassius auratus)	X	May-Jun	5,E	5,E	Z	5,F	Z	
Carp (Cyprinus carpio)	X	May-Aug	5,E	5,E	Z	5,E	Z	
Emerald Shiner (Notropis atherinoides)		Jul-Aug	B,D	B	T,V	B	T,V	Concentrated in less than 60 feet of water[5]
Spottail Shiner (Notropis hudsonius)		May-Jul	1,G	B	T,V	B	T,V	Concentrated in shallow water[5]
Quillback (Carpiodes cyprinus)		Apr-May	4,5,A or B	B	Z	B	Z	
White Sucker (Catostomus commersoni)		May-Jun	1,F or A	B,D & E	Z,V	B,D &E	Z,V	
Channel Catfish (Ictalurus punctatus)		Jun-Aug	7,E,A, or B	B	Z	B	Z	
Burbot (Lota lota)		Jan-Mar	1,B,E	B,F	W	B	Y,W	
White Bass (Morone chrysops)		May-Jun	B,D,G	B	V	B	V,U	
Smallmouth Bass (Micropterus dolomieui)		May-Jul	1,2,B or A	E,B or A	S,V,W	B or A	S,W,Y	Cooler water in summer
Largemouth Bass (Micropterus salmoides)		May-Aug	4,5,E	E,5	V,W	E,5	W,Y	Low tolerance to low O_2 levels
Yellow Perch (Perca flavescens)		Apr-May	1 or 5,E,(A)[6]	E	V,W	B,D or E	V,W,X	Tolerate in turbid water
Sauger (Stizostedion canadense)		May-Jun	1,G,(A)[3]	E	V,W	B,D or E	W,X	Tolerate in turbid water
Walleye (Stizostedion vitreum)		Apr-Jun	1,G,(A)[6]	G	V,X	B,D or E	Y,W	
Freshwater Drum (Aplodinotus grunniens)		Jul-Sep,Jun[2]	1,E,(A)[6]	1,E	V,W	B,D or E	W	

*Habitat Types

1 gravel-sand
2 large boulders
3 rocks
4 sandy silt-mud
5 vegetation
6 no vegetation
7 protected
8 swift water

**Location

A river/stream/tributary
B open lake
C deep water
D medium depth water
E shallow water
F near shoreline
G shoal
H rocky ledge
I (sea)

***Food Types

R parasitic
S surface insects
T phytoplankton/algae
U microplankton
V zooplankton
W benthic invertebrates
X small fish
Y fish
Z plant and animals bottom material

(1)Modified from W.B. Scott and E.J. Crossman, Freshwater Fishes of Canada, Fisheries Research Board of Canada, Ottawa, 1973.

(2)"Western Lake Erie Fish Larvae Study: 1975 Preliminary Report," C.E. Herdendorf, et al., OSU, CLEAR, Columbus, Ohio, 1975.

(3)W. Hartman, "Effects of Exploitation, Environmental Changes, and New Species on the Fish Habitats and Resources of Lake Erie," Tech. Rept. No. 22, Great Lakes Fishery Commission, April 1973.

(4)John E. Gannon and A. M. Beeton, "The Decline of the Large Zooplankton, Limnocalanus Marcrusur Sars, (Copepoda: Calanoida) in Lake Erie," in Proc. 14th Conf. Great Lakes Research, 1971.

(5)Roger Kenyon, "A Commercial Fish Study of the Eastern Basin of Lake Erie," Commercial Fisheries Research and Development Act, Project 3-167-R-2, 1975.

(6)Aquatic Ecology Associates, "Aquatic and Terrestrial Studies - Lakefront Plant, Conneaut, Ohio, 1977."

Table 2-403

Average Combined Annual United States and Canadian Production (Thousands of Pounds) of Major Commerical Fishes(1) from Lake Erie

Period	Lake Stru-geon	Northern Pike	Lake Herring	Sauger(2)	White-fish	Blue Pike(3)	Walleye	Yellow Perch	Smelt	Fresh-water Drum	White Bass(2)	Sucker(2)	Channel Catfish(4)	Carp	Others(5)	Total Production
1879-1909(6)	1,052	1,356	25,625	3,700	2,402	10,797(7)	--	2,791	--	1,061	611	1,350	604	2,480	100	53,929
1910-1919(6)	77	1,250	27,201	3,656	1,945	9,277	1,736	3,017	--	2,499	383	1,120	1,110	7,544	2,015	63,850
1920-1929(6)	39	77	14,126	2,437	1,675	11,292	1,577	5,356	--	2,367	360	1,090	681	3,189	1,476	45,742
1930-1934	39	62	764	1,943	2,094	14,623	2,113	12,382	--	2,381	447	1,462	700	2,659	1,594	43,263
1935-1939	31	29	1,070	1,414	2,696	18,526	3,515	6,444	--	3,359	655	980	641	2,689	1,964	44,013
1940-1944	22	37	283	878	4,058	13,517	3,779	3,869	--	3,624	553	628	948	2,593	1,744	36,533
1945-1949	25	21	6,067	567	4,701	12,509	5,807	4,245	--	3,965	701	506	1,093	2,077	2,226	44,510
1950-1954	14	12	475	354	2,297	13,535	7,566	6,784	890	3,492	3,485	661	1,589	3,007	973	45,134
1955-1959	14	14	128	21	749	10,078	10,267	19,540	4,345	4,020	5,092	413	1,770	4,171	733	61,355
1960-1964	4	2	8	1	19	3	1,484	20,219	13,508	5,770	4,111	333	1,484	4,276	792	52,014
1965-1969	1	2	--	--	5	--	941	26,662	13,489	3,465	2,439	224	898	3,241	1,141	52,508
Largest Catch	5,187	2,873	48,823	6,181	7,099	26,788	15,405	33,166	19,182	6,880	9,451	2,024	2,228	13,419	--	76,313
Year of Largest Catch	1885	1908	1918	1916	1949	1936	1956	1969	1962	1961	1954	1930	1917	1914	--	1915

(1) Species that have had an annual production greater than 1 million pounds.

(2) U.S. catch only until 1952.

(3) Catches of walleye and blue pike combined through 1914.

(4) Includes bullhead through 1951.

(5) Species normally less than 1 million pounds (goldfish, bullheads, burbot).

(6) Average for years of record.

(7) Probably composed of 8 to 9 million pounds of blue pike and the remainder walleye.

Source: Wilbur L. Hartman, Technical Report No. 22, Great Lakes Fishery Commission, April, 1973.

suitable for spawning have a marked effect on available spawning habitat for such species as lake whitefish (Coregonus clupeaformis), lake sturgeon (Acipenser fulvescens), walleye (Stizostedion vitreum), sauger (Stizostedion canadense), blue pike (Stizostedion glaucum), northern pike (Esox lucius), and muskellunge (Esox masquinongy). Breeding populations of the first three have essentially been restricted to the lake. (2-232) Fishing pressure, in conjunction with the previously mentioned factors, could possibly explain the decline of these fish species, especially the late-maturing lake sturgeon. The muskellunge, an important recreational species has also declined in Lake Erie. Muskellange spawn in shallow, heavily vegetated waters, a habitat type which has been considerably reduced in Lake Erie waters. Contrary to the above species, the presently more successful yellow perch (Perca flavescens), white bass (Morone chrysops), smelt (Osmerus mordax), and freshwater drum (Aplodinotus grunniens) do not necessarily utilize tributaries as spawning habitat, although yellow perch and freshwater drum may have utilized Conneaut Creek for spawning. Other species such as carp (Cyprinus caprio), and goldfish (Carassius auratus that do spawn in shallow, vegetated bays, have high tolerance to turbidity. The slight warming of the lake, along with anoxic conditions in cooler hypolimnetic waters is believed to have had a drastic effect on those species that require cooler water in the summer. Lake trout (Salvelinus namaycush), lake whitefish, and lake herring (Coregonus artedii) are all at the southern limit of their range. They have been restricted to the cooler waters of the eastern basin where they are more susceptible to fishing pressure. All phases of the life history of whitefish and herring are temperature-limited as well. Furthermore, lake trout, not part of the fishery in this century, is a late maturing fish. (2-232) Successfully introduced species (some with the opening of the Welland Canal) may well have added competitive pressure. Alewife (Alosa pseudoharengus) and smelt occupy the same hypolimnetic waters in the summer as herring and whitefish and consume many of the same food types. The sea lamprey (Petromyzon marinus) has not become well established in Lake Erie due to lack of sufficient spawning tributaries, but may still have added some pressure on larger fishes. Goldfish, carp and gizzard shad (Dorosoma cepedianum) are well suited to the warmer, silty or more eutrophic lake environments. Several of the above-mentioned species may have already been extirpated from the lake. Native Erie lake trout probably no longer exist. (2-232) Although U.S. Fish and Wildlife Service data indicated capture of one small lake trout off Conneaut in the spring of 1977, this was likely a stocked fish. A variety of muskellunge is also rare in Lake Erie (2-235). Blue pike, prominent in the commercial fishery in the first half of this century may well be extinct. Sauger (close to extirpation in Lake Erie except for stocked populations) and blue pike

faced an additional problem with the small remaining number of natural populations disappearing through introgressive hybridization with walleye stock. (2-232)

e) Commercial Fishery

2.826
The present commercial fishery is dominated by five species (refer to Table 2-404). The most recent catch (averaged over the period 1973 to 1976), is lower than any of the averages reported since the turn of the century, with the exception of the early 1940's. The only other period as low as the recent one was reported in the early 1930's. Total 1976 production was the lowest since 1951 (2-236) with the catches for the last two years and the decline in yellow perch abundance the major contributors. The 1976 total catch for this species was less than one-fourth the catch in 1969, one of the peak years. Smelt catches and those of "low value" species have picked up some of the slack. Smelt now dominates the Lake Erie fishery, with the greatest proportion taken in Canadian waters. Walleye production, which dominated the fishery along with yellow perch and blue pike in the 1950's, was well below 500,000 pounds. However, commercial harvest of this species was prohibited in Ohio waters during this time period.

2.827
Canadian production has dominated the Lake Erie fishery during the past 20 years. It has represented approximately 75 percent of total fishery production in more recent years. The U.S. income from the Lake Erie fishery has ranged from 1.5 to 2.2 million dollars annually in the last three years. In fact, the decline in overall lake production for 1976 was entirely in the Canadian landings. Carp predominated 1976 U.S. production, followed by yellow perch and white bass. Together, these represented two-thirds of the U.S. total catch. (2-236) Over the past three years, the Ohio fisheries share of total U.S. production in Lake Erie has been slightly above 85 percent. Eighty-two percent of the major species are harvested between March and August and the Western Basin is the most productive. Between 1973 and 1975, yellow perch represented 20 percent of the total Ohio catch, dropping slightly below this in 1976. Most of the yellow perch are caught by gill net in the spring and fall, and in 1976, 89.9 percent of the Ohio yellow perch were harvested in this manner. These were caught in the Central Basin, the majority (over 80 percent) being netted in the Huron to Fairport section of Ohio waters. Freshwater drum were a distant second in Ohio waters catch from the Central Basin. (2-237) Figure 2-145 indicates catch per unit effort for the gill net yellow perch fishery in the Ohio waters of the Central Basin. These data reflect the decrease in abundance of this species. The Pennsylvania fishery is much smaller than the Ohio fishery probably reflecting the limited Lake Erie shore area in

Table 2-404

Combined United States and Canadian Production for the Top Six Species of Fish and Yearly Totals for Commercial Catches -- 1973-1976[1]

(Pounds Caught)

	1973 (lbs)	1974 (lbs)	1975 (lbs)	1976 (lbs)
Total Yearly Catch of All Species	48,181,100 ($8,517,800)	48,533,900 ($7,720,900)	39,035,100 ($7,972,700)	34,524,900 ($8,547,000)
Top Six "Species" Caught				
Yellow Perch	19,917,800	14,581,500	10,124,800	6,394,600
Smelt	17,063,400	15,808,300	16,934,200	17,280,600
White Bass	3,921,500	5,258,700	4,255,000	2,599,900
Carp	2,452,600	3,152,400	3,285,300	3,191,000
"Other Species"[2]	2,244,200	7,307,200	1,861,700	1,611,800
Freshwater Drum	1,505,700	948,500	1,185,100	1,362,800

(1) These figures were preliminary at the time they were reported and not for official publication.

(2) Low value fishes.

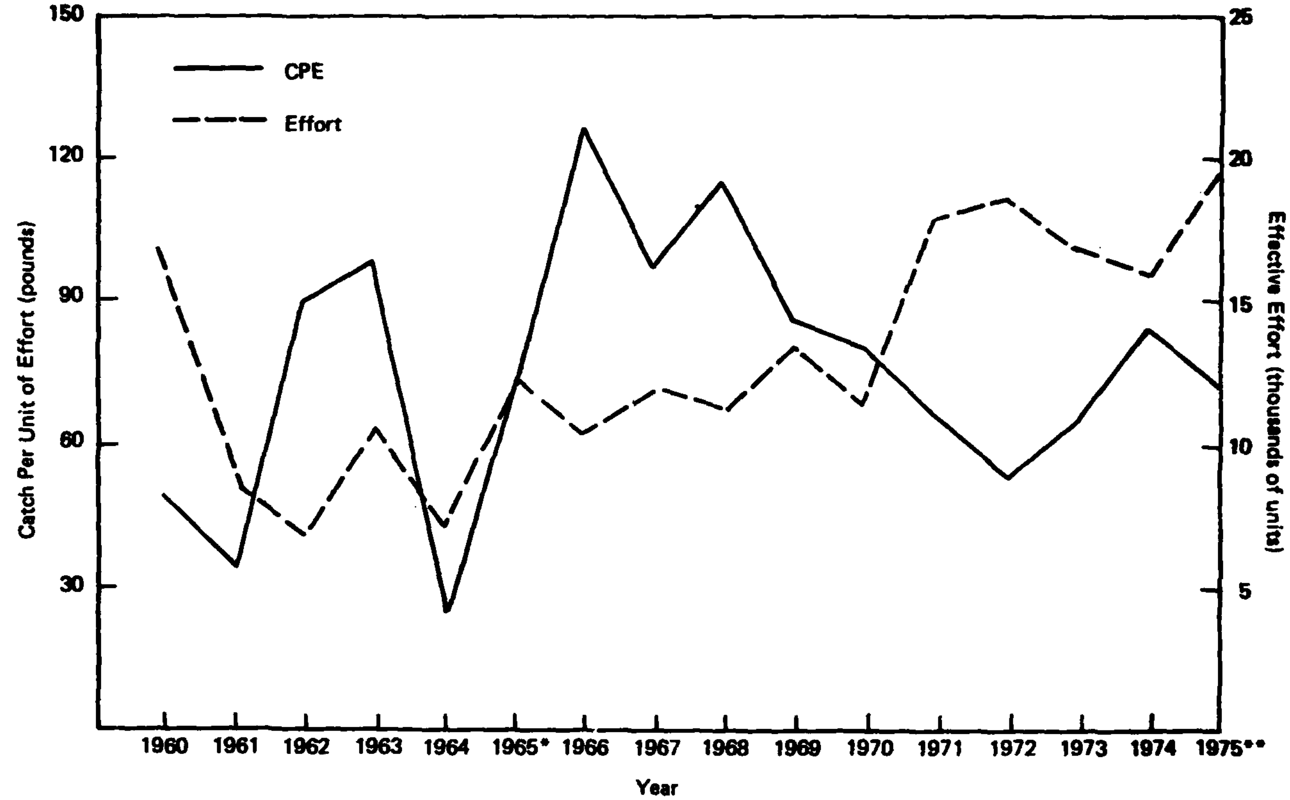
Source: Modified from: "Minutes," Lake Erie Committee 1975 Annual Meeting, Great Lakes Fishery Commission.
"Minutes," Lake Erie Committee 1976 Annual Meeting, Great Lakes Fishery Commission.
K.M. Muth, U.S. Fish & Wildlife Service "Status of Major Species in Lake Erie, 1976 Commerical Catch Statistics, Current Studies, and Future Plans."

the Commonwealth. For 1969-197_, harvests ranged between 250,000 and 500,00 pounds (compared to 7 to 9.15 million pounds for Ohio). Almost the entire catch was yellow perch. Analysis by the Pennsyvlania Fish Commission indicates that harvest for yellow perch continues to exceed biological production for fishable age stock in this area. (2-238)

2.828
Much of the attention of agencies involved in the Lake Erie fishery has been directed toward studies that approximate year class success of various fish species, while fish stocking efforts have been directed mainly at the recreational fishery. Ohio has prohibited commercial catches of walleye during this decade and restricted white bass catches in 1971 and 1972. Recent surveys indicate that these restrictions have allowed increases in the population of the former and helped to increase spawning potential in the latter. Unseasonably high spring temperatures in 1976 may have significantly affected poor hatches of walleye and yellow perch in the Western Basin. Walleye stocks in the Eastern Basin are separate, and continue to be commercially harvested with no drastic decline noted although fishing pressure for this species is lower in this area. In 1976, there was a more stringent enforcement of the 8-inch minimum size limited for yellow perch, which also contributed to the decrease in landings for this species. (2-236) However, no increase in the minimum size limit for protection of yellow perch has been agreed upon by all the fisheries involved although this has been discussed at recent annual Lake Erie Committee Meetings.

f) Recreational Fishery

2.829
The recreational fishery in Lake Erie is sizable. Estimates for the Ohio sport fishery show 1.69 million pounds caught in 1975. These catches were predominated by yellow perch, white bass, freshwater drum and walleye. (2-239) Although fish stocking programs in Lake Erie have been ongoing for many years more recent efforts have been directed toward the increase of lake trout populations in the Central and Eastern Basins (New York and Pennsylvania waters) and sauger in Sandusky Bay. (2-236) Prior to the initiation of these programs the sauger and lake trout were threatened with extirpation from Lake Erie. A major effort at the establishment of successful anadromous salmonids stock in Lake Erie, for spring and fall recreational fishing, has been carried out by State and provincial agencies (refer to Table 2-405). The design of this program has been toward a "put and take" fishery. Hatchery raised fingerlings or smelt, and eggs have been added to tributaries with the expectation that adults will return on spawning runs. Rainbow trout natural reproduction has been



*Decrease in minimum legal size from 8½" to 8" in 1965.
** 1975 data are preliminary.

Source: "Commercial Fish Landings, Lake Erie–1975," Department of Natural Resources, Ohio Division of Wildlife, Publication 200, p. 11.

FIGURE 2–145 YELLOW PERCH CATCH PER GILL NET EFFORT

report in New York State. (2-4J^r) Natural rainbow trout reproduction is likely in tributaries to Walnut Creek and is reported for Crooked and Raccoon Creeks. The degree to which any Lake Erie tributaries can sustain natural reproductior is unknown at this point in time. Though tagging studies introduced salmonids species were observed to migrate clockwise around the lake, residing in cooler north shore Lake Erie waters during the summer. Return of adult fish to planted streams has varied by State, although the number of tagged fish is not sufficient for accurate monitoring of straying. Returns seem to have been more successful for Pennsylvania with over 80 percent of clipped fish returning to Pennsylvania waters. However, a number of the clipped salmonids caught in Ohio were of Pennsylvania origin, and surveys of the Chagrin River (Ohio) have indicated use of that stream by a larger number of strays. (2-236, 241)

Lake Erie Nearshore Areas to the East and West of the Proposed Site

a) Perry Site

2.830
The NUS Corporation conducted an aquatic sampling program (1971-1972) for the Perry Nuclear Power Plant site of The Cleveland Electric Illuminating Company. This site is located approximately halfway between Fairport and Ashtabula, Ohio, about 20 miles southwest of the proposed Lakefront site. About two miles of the nearshore area was sampled to a depth of about 30 feet (one mile offshore), from December of 1971 through the fall of 1972. (2-242) The survey illustrated a numerical dominance by Chrysophyta (yellow-green algae) species in the spring phytoplankton surveys, replaced by Chlorophyta (green algae) dominance during the summer, and becoming more important again with a fall pulse. Cyanophyta (blue-green algae) were present, showing a September pulse, but not numerically important compared to other species present. (2-242, 243) Similar species were found in samples taken at the top and bottom of the water column, although the most numerically important species might shift. Seasonal pulses were also reported for zooplankton species. The smaller protozoans and rotifers predominated in the early spring, with protozoans dominant in March and rotifer species forming 86 percent or more of all samples in April. By July, copepods (predominantly Cyclops bicuspidatus) were the most abundant species in most samples. In August, cladocerans and copepods were still very abundant, but rotifer populations had increased in September samples. A fall pulse of copepods was observed in October, although the protozoans and rotifers still predominated. The greatest numbers of zooplankton were collected during August with an average mean total number of 2,021 organisms/liter. A smaller pulse, with an average

Table 2-405

Salmonids Stocked in Lake Erie and Tributaries -- 1973-1977

	Proposed 1974(1)	Proposed 1975(1)	Proposed 1976(1)	Stocked 1977
Michigan				
Coho	-	200,000		
Chinook	450,000	400,000		
Steelhead/Rainbow	60,000	30,000	61,500	(Unknown)
Brown	-	-		
Lake	-	-		
Ohio				
Coho	150,000(?)(2)	100,000	150,000(?)	
Chinook	-	200,000	125,000-200,000(?)	32,151
Steelhead/Rainbow	85,000	30,000	70,000	
Brown	-	-	-	
Lake	-	-	-	
Pennsylvania				
Coho	371,000	328,000	240,000	609,256(3)
Chinook	270,000	450,000	650,000	800,075
Steelhead/Rainbow	-	-	93,450	30,937
Brown	-	-	2,830	2,150 (32,000
Lake	some(?)(2)	40,000	20,000	- proposed
Others			5,020	800 for lake)
New York				(Unknown)
Coho	43,000	50,000	200,000	
Chinook	100,000	50,000	50,000	
Steelhead/Rainbow	30,000	-	75,000	
Brown	20,000	16,000	50,000	
Lake	-	150,000		

Table 2-405 (Continued)

	Proposed 1974[1]	Proposed 1975[1]	Proposed 1976[1]	Stocked 1977
Ontario				
Steelhead/Rainbow	302,000	274,000	236,560	(Unknown)

Source: [1] Modified from "minutes," Lake Erie Committee 1974 Annual Meeting, Great Lakes Fishery Commission Annual Meetings, 1975, 1976.

[2] Numbers uncertain.
Personal communication, Vincent LaConte, Ohio Department Natural Resources.

[3] Personal communication, Roger Kenyon, Pennsylvania Fish Commission.

mean total number of 386 organisms/liter, was observed in April. (2-242) The use of a dredge for benthos sampling was difficult due to the predominance at an exposed shale bottom in the nearshore area off the Perry site. Thus, samples from "inner" transect stations, "middle" transect stations, and "outer" transect stations were each averaged for use in illustrating trends for depth and seasonal variations. In general, the mean number of species as well as the mean number of individuals per square meter, increased with depth. (2-242, 243) Selected benthic data collected at the Perry site, indicating when the largest population were found at each depth is presented in Table 2-406. Crustacea, non-Chironomid insecta, Mollusca, and other representatives of the benthic community were generally more prevalent (although numbers were small) during the spring and early summer. This might indicate sensitivity to lowered oxygen levels along the bottom during late summer months, although DO values for these months were not included in the report. (2-243) During the sampling period, December 1971 to October 1972. 730 fish, representing 16 species were collected in gill nets. with the majority of fish captured in June and September (refer to Table 2-407). Freshwater drum and yellow perch dominated the spring catch. Yellow perch made up most of the catches during the rest of the year, with the majority being caught in September. Although numbers were smaller, walleye were found throughout the year, as were carp, suckers, and white bass. Three Coho salmon were caught in the fall and larger numbers of white suckers and yellow bullhead were found in the nearshore area in the late spring.

b) Lake City

2.831
An additional study, the results of which have not yet been fully compiled, has been conducted in the nearshore area of Lake Erie for the Lake City site of a proposed power plant facility. Limited data are available for December 1973 through May 1974. Lake City is located approximately 10 miles east of the proposed Lakefront Plant site and exhibits similarities to the proposed steel plant as well as the Perry site. Although the depth of the lake drops off more rapidly than the Lakefront site, the nearshore area off Elk Creek (Lake City) is scoured almost to bedrock. (2-244) Another similarity to the proposed Lakefront site is the fact that a fairly large tributary, Elk Creek, enters the Lake where the sampling was conducted. Samples were collected over approximately 1.5 miles of nearshore area to the west of Elk Creek, and out a distance of 2,000 feet (18-24 foot depth). (2-245) The phytoplankton and zooplankton observations from December 1973 through May 1974 are reported in Table 2-408. Artificial substrate samplers were used for benthos collection since bedrock bottom of the nearshore did not lend itself to sampling with

Table 2-406

Benthos Collection Data at the Perry Site

	"Inner" Transect	"Middle" Transect		"Outer" Transect	
Month	Sept.	Sept.	April	Dec.	Sept.
% of All Benthos in Each Transect[1]	86.69%	63.01%	25.22%	52.36%	28.26%
Predominant Species	Oligochaetes or Chironomids:	Oligochaetes:		Oligochaetes or Chironomids	
	Aulodrilus piqueti	Limnodrilus hoffmeisteri		Aulodrilus piqueti	
	immature tubificids	immature tubificids		Limnodrilus hoffmeisteri	
	Chironomus riparius			immature tubificids	

(1) *Indicates* percentage of all benthos in all collections at that station represented by the number in the collection for the particular month displayed.

Source: 1971-1972 Annual Report of the Aquatic Ecological Program at the Perry Site, Vol. II, NUS Corporation.

Table 2-407

Numbers of Fishes Captured by Gillnet off Perry Site, Lake Erie -- 1971, 1972

	Dec. '71	June '72	July '72	Aug. '72	Sept. '72	Oct. '72
Bullhead	1					
Carp		18	3	3	1	2
Carp-Goldfish hybrid				1	1	1
Channel Catfish	1	2	4	5		
Coho Salmon					3	
Freshwater Drum		146	12	7	9	
Gizzard Shad	1			2		
Golden Redhorse	3	1				
Northern Hog Sucker		1				
Redhorse Sucker				1	1	
Rock Bass		4			3	
Rainbow Smelt		7				10
Smallmouth Bass		1				
Stonecat					4	1
Walleye	16	14		12	6	4
White Bass	3	2		2	1	1
White Sucker		10		4	3	1
Yellow Bullhead		13	2			
Yellow Perch	20	95	70	37	180	1
Totals	270	314	91	74	212	19

Source: Modified from 1971-1972. Annual Report of the Aquatic Ecological Program at Perry Site, Volume II, pg. 85.

Table 2-408

Phytoplankton and Zooplankton Collected Offshore of Lake City -- Dec. 1973 - May 1974

Predominant Species	Winter (Dec '73)	Spring (April '74)	Early Summer (May '74)
Phytoplankton	(Greatest Diveristy of Species)		(Maximum Cell Counts)
Tabellaria	Numerically important species at various stations	Somewhat important numerically	Numerically less important species
Fragillaria	Numerically important species at various stations	Somewhat important numerically	Numerically less important species
Asterionella	Numerically important species at various stations	Somewhat important numerically	Numerically less important species
Stephanodiscus	Numerically important species at various stations		
Melosira	Numerically important species at various stations	56-95% of all individuals in surface and bottom samples	75-98% of all samples
Pediastrum	Numerically important species at various stations		
Ankistrodesmus	Numerically important species at various stations		
Zooplankton	50 individuals/ml	283^{+} individuals/ml	Not yet reported
Bosmina coregoni	Dominated bottom in Dec. and Jan.		
Polyarthra vulgaris	Dominated surface in Dec. and Jan.		
Epistilis plicatilis	January numerical dominant		
Keratella cochlearis	January numerical dominant		
Keratella quadrata	January numerical dominant		
juvenile cyclops	January numerical dominant		
Rotatoria	February numerical dominant		
Vorticella microstomum		April numerical dominant	
Polyarthra dolichoptera		April numerical dominant	

Source: Modified from unpublished data for Lake City site, Aquatic Ecology Associates.

a ponar dredge. Results for early spring indicated an abundance of trichoptera and ephemeroptera larvae. These organisms generally inhabit waters of good to excellent quality. (2-246) Chironomidae were equally important in these initial samples. (2-246) Longer term results are not available as of this date. Over 1,200 fish were collected by gill net off Lake City from April to November. Yellow perch, walleye, freshwater drum, white bass, smallmouth bass, alewife, suckers, and channel catfish were prevalent during spring months as shown in Table 2-409. These spring collections of suckers, perch, bass and walleye contained individuals in breeding condition. Suckers, gizzard shad, and white bass were present during summer months and adult salmonids were found in the fall. Yellow perch were found migrating west to east along the shoreline in April and May, while many of the other species and individuals collected in April were clustered near the mouth of Elk Creek.

2.832
Ichthyoplankton tows during the month of April contained no larval fish species. However, tows during June contained gizzard shad, white bass, yellow perch, Notropis sp, and large numbers of logperch. In July icthyoplankton samples contained almost three times the number of individuals as June samples. The same species were found, as well as smelt and trout-perch. (2-247) An initial seining effort along the shore also indicated the presence of forage species. (2-245) Samples from the mouth of Elk Creek (refer to Tables 2-410 and 2-411) indicate much lower diversity in the pool habitat compared to the riffle area. In the former area, highest diversities of species occurred in May, August, late September, and November. Except for August, these increases in diversity were largely the result of captures of lake resident species. Similarly, the highest diversity in the riffle area occurred in May samples. Major contributions to this increase in the number of taxa were from lake species. Decreases in the number of taxa and the number of individuals were noted for summer months as lake species left the area. Stomach analyses were done on most of the species listed above, and generally coincided with their known feeding preferences. There was an indication that some fish, like suckers, freshwater drum were feeding on matrial carried out of tributary streams. (2-247) Both of the Perry and Lake City studies provide data too limited to establish yearly trends. Of the phytoplankton and zooplankton samples which can be compared to data for the lakefront site, all show dominance by diatoms, protozoans, and rotifers in the spring, with the dominant species being similar to those reported by other studies in Lake Erie. Benthos collected in both areas, including Trichopteran and Ephemeropteran species, usually inhabit waters of good quality. However, the more facultative Oligochaetes definitely predominated at the Perry Site.

Table 2-409

Numbers of Fishes Captured by Gillnets Off

Lake City Site, Lake Erie -- 1974

Species	4-11	5-11	6-3	7-2	8-7	9-6	9-19	10-3	11-12	Total
Longnose Gar	-	1	-	-	-	-	-	-	-	1
Gizzard Shad	1	1	2	1	126	74	100	-	2	307
Alewife	4	-	17	39	1	-	-	-	-	61
Rainbow Smelt	1	-	-	-	-	-	-	1	-	2
Rainbow Trout	1	-	-	-	-	-	-	3	1	5
Coho Salmon	6	-	-	-	-	8	6	12	2	34
Chinook Salmon	-	-	-	-	-	6	13	6	-	25
Common White Sucker	5	16	20	5	6	17	9	-	2	80
Golden Redhorse Sucker	5	-	5	4	4	4	3	-	9	34
Black Redhorse Sucker	2	-	-	-	-	-	-	-	-	2
Northern Hog Sucker	1	-	3	-	-	-	1	-	-	5
Silver Redhorse Sucker	-	-	-	-	-	1	-	-	-	1
Shorthead Redhorse Sucker	-	2	6	1	5	1	-	-	-	15
Quillback Carpsucker	-	-	-	-	2	1	-	-	-	3
Carp	-	-	2	5	-	-	1	-	-	8
Goldfish	-	-	1	2	1	-	-	-	-	4
Channel Catfish	1	5	10	4	1	1	-	-	1	23
Yellow Bullhead	-	1	-	-	-	-	-	-	-	1
Stonecat	-	-	1	2	-	-	-	-	-	3
Trout Perch	1	3	-	-	-	-	-	-	-	4
White Bass	5	12	4	5	6	12	3	-	-	47
Smallmouth Bass	9	7	14	-	5	4	-	-	-	39
Rockbass	-	-	6	1	1	-	1	-	-	9
Yellow Perch	2	157	212	13	6	3	-	-	-	393
Walleye	1	7	51	12	1	11	3	-	3	89
Freshwater Drum	1	4	15	18	5	8	1	1	-	53
Total No. Individuals	46	232	369	112	170	149	141	23	20	1248

Source: Modified from unpublished data for Lake City site, Aquatic Ecology Associates.

Table 2-410

Fish Collected from the First Pool of Elk Creek,
Lake City Site, Lake Erie -- 1974

Species	Collection Dates 5-23	6-6	7-3	8-5	9-4	9-20	10-3	11-6	Total
Gizzard Shad	1	-	-	-	-	-	-	-	2
Rainbow Trout	-	-	-	-	-	-	-	2	2
Coho Salmon	-	-	-	-	1	7	7	1	16
Chinook Salmon	-	-	-	-	-	2	-	-	2
Common White Sucker	2	-	-	-	-	1	-	4	7
Golden Redhorse Sucker	1	-	-	3	3	1	4	11	23
Northern Hog Sucker	-	-	-	-	-		-	-	1
Quillback Carpsucker	-	-	-	1	-	-	-	-	1
Carp	3	-	1	-	-	-	-	-	4
Goldfish	1	-	-	2	-	2	-	-	5
Emerald Shiner	-	-	-	-	-	-	-	3	3
Common Shiner	-	-	-	-	4	1	-	1	6
Spotfin Shiner	1	-	-	3	-	1	-	1	6
Bluntnose Minnow	-	-	-	-	-	-	-	1	1
Brown Bullhead	-	-	-	-	-	1	-	-	1
Northern Brook Silversides	-	-	-	-	-	3	-	-	3
Largemouth Bass	-	-	-	7	-	-	-	-	7
Smallmouth Bass	9	-	-	2	-	-	-	-	11
Pumpkinseed	-	-	-	7	-	1	-	-	8
Bluegill	-	-	-	1	-	-	-	-	1
Freshwater Drum	1	-	-	-	-	-	-	-	1
Total No. Individuals	20	0	1	26	7	20	11	23	109
Total No. Species	8	0	1	8	3	11	2	8	21

Source: Modified from unpublished data for Lake City site, Aquatic Ecology Associates.

Table 2-411

Number of Fish Collected from the First Riffle Above the Mouth of Elk Creek Between December 1973 and November 1974 at Lake City, Pennsylvania

Species	'73 D	'74 J	F	M	A	M	J	J	A	S	O	N
Coho Salmon	3	1								9		1
Rainbow Trout	2			17		13	1	1	1			1
Stoneroller	4	67		66		15	6	13	80	9	2	15
Carp	10					5	1					
Bigeye Chub	9	21				42	13	1	7	6	1	5
Common Shiner	25	81	(FROZEN)	222	(HIGH WATER)	79	13	15	70	64	19	36
Mimic Shiner	2	11		84		62	10	7		5	1	30
Bluntnose Minnow	14	9		45		113	27	21	55	33	16	47
White Sucker	4	41		32		15	1	8	9	1	4	2
Brown Bullhead	1					3		1	2			
Rock Bass	4	4				2		14	10	3		
Pumpkinseed	1					7	4	1	12	7	1	
Smallmouth Bass	4	3				1	6	24	34	22	1	4
Silverjaw Minnow		12		15		6	7					
Fathead Minnow		6		3		9		1		1		1
Blacknose Dace		1		1		1		3	1			1
Longnose Dace		2		27		8	1	3	2	1	1	1
Creek Chub		1		3		1						
Northern Hog Sucker		5		5		7	4	15	30	12	1	7
Logperch		1				26	216	44	15	5		
Central Mudminnow				1								
Goldfish				1					2			
Emerald Shiner				9		23						
Spotfin Shiner				1		6	4	8	4	1		
Bluegill				1		3	1	10	6	2	6	
Rainbow Darter				21		10		3	40	18	4	
Golden Shiner						1	1					
Quillback						1		2			1	
Silver Redhorse						1						
Black Redhorse						32						
Golden Redhorse						21	6	9	99	52	4	
Black Bullhead						1	1					
Stonecat						12	3	5	5	2		
Largemouth Bass							3	4				
Freshwater Drum							5					
Shorthead Redhorse							7					
River Chub												1
No. Species	13	16	-	18	-	30	23	23	20	19	14	14
No. Individuals	83	266	-	554	-	526	341	213	484	253	62	152

Source: Modified from unpublished data for Lake City site, Aquatic Ecology Associates.

c) U.S. Fish and Wildlife Se.. ce Studies

2.833
The U.S. Fish and Wildlife Service collected data on fish species and distribution in the Central Basin of Lake Erie during cruises made in May, July, and September 1977. In addition to setting gill nets, trawls were also performed and bottom-water depths for a number of stations, including several off Conneaut, Fairfield, Ashtabula, and Erie City. The gill net results for Conneaut were similar to those obtained by Aquatic Ecology Associates during their gill netting efforts off the Lakefront site. Adult yellow perch predominated in May, whi.e by July adult gizzard shad were most abundant. The prevalent ad lt species in September was still gizzard shad, followed by walleye. The mid-water trawls for Conneaut revealed that in May the predominant species at all contours (40, 50, 60, and 70 feet) were young and adult rainbow smelt, and that by August, juvenile emerald shiners were most abundant, followed by juvenile rainbow smelt. The mid-water trawl data from Ashtabula and Erie were basically similar to that obtained near Conneaut. The deep-water Conneaut trawls recorded young and then adult rainbow smelt as the most abundant species at all contours in May. The secondary species at 40 feet were adult trout perch and spottail shiner, while only rainbow smelt were collected past 50 feet. The results of deep trawls in May were much the same in Ashtabula, Erie and Fairport, with a few exceptions. In Erie, more yellow perch were recorded at 40 feet than at Conneaut, and both Erie and Fairport had more adult than young rainbow smelt. The July deep-water trawls near Conneaut showed juvenile gizzard shad, alewife and rainbow smelt most abundant at 40 feet, while at 50 feet the most abundant juvenile was trout perch, followed by rainbow smelt. Adult freshwater drum and yellow perch were recorded along with the predominant rainbow smelt juveniles at 60 feet, while at 70 feet adult trout perch were secondary to juvenile rainbow smelt. Ashtabula showed similar distributions. In Erie no gizzard shad were observed at the 40-foot depth but young and adult trout perch were taken there, and some yellow perch were collected at the 50-foot depth. Only yellow perch were found at 40 feet in Fairport, but the results for the deeper contours were similar. Two burbot, uncommon in the central basin, were captured at 70 feet in July, one off Ashtabula and the other off Erie. By September, the deep trawl data for Conneaut showed juvenile rainbow smelt and spottail shiner as the most abundant species at 40 and 50 feet, followed by juvenile trout-perch and white bass. At 60 feet and 70 feet, adult rainbow smelt were most abundant. In Erie and Fairport very similar distributions were noted, except in Fairfield, juvenile gizzard shad was the secondary species at the 60-foot contour. One lake whitefish, uncommon in the central basin, was recorded in the catch from the 70-foot contour off Erie, Pa. Dissolved oxygen (DO) levels were recorded for each

trawl and were generally found be low in July, but the lowest recorded levels occurred at the 60-foot contour off Conneaut during the month of August (1.0 and 3.7 ppm). At Fairfield dissolved oxygen was 0.5 ppm during the same time period. In general, the DO level was higher in Conneaut than off the other three cities, and was almost always above 5 ppm. Periodic stratification was evident at the various sampling stations equal to or greater than 40 feet deep throughout the summer. (2-248)

d) Environmental Research Associates, Inc. Studies

2.834
Data on ichthyoplankton in Ashtabula Harbor were collected by Andrew White of Environmental Research Associates, Inc., in 1975-1976. The lowest numbers of larvae (per 1,000 cubic meters) were recorded in May, when the predominant species were logperch darter, smelt, and trout perch. The greatest numbers of larvae were observed in June, when spottail shiner was predominant, followed by carp and alewife. In the first two weeks of July, emerald and spottail shiners and gizzard shad were the three most abundant species, while in the last two weeks carp, emerald shiners and Johnny darter were predominant. Emerald shiners and carp were still prevalent in August. (2-249) No significant differences in the use of various areas within the harbor by juveniles were apparent.

Summary

2.835
The various fish surveys indicate use of the Lake Erie nearshore area by a number of commercially and recreationally important species. Sport and commercial harvest data for this area of the Central Basin indicate the presence (and importance) of similar species. Yellow perch first, and then small-mouth bass, freshwater drum, and white bass were the most frequently reported fish in sport harvest data for the Ashtabula/Conneaut area in 1975. (2-250) Yellow perch freshwater drum made up most of the commercial catch reported for Conneaut and Ashtabula Harbors in 1976. Catches for these ports represented about five percent of the total fish (7.78 million pounds) reported for the Ohio Commercial Fishery. Yellow perch, and to a lesser extent, white bass, walleye, and sheepshead and emerald shiners, were reported for the Pennsylvania waters of the Port of Conneaut and for Erie. These made up almost all of the Pennsylvania commercial catch for 1976 (about 336 thousand pounds). The 1976 Conneaut and Ashtabula catches represented the largest proportion of the total Ohio catch in the past five years. The Ohio catch has remained between 7.0 and 8.65 million pounds and the ports of Ashtabula and Conneaut contributed three to four percent of this catch from 1972-1975. Yellow perch

have comprised over 90 percent of these eastern Ohio catches. Pennsylvania production has ranged from approximately 0.25-0.50 million pounds; Conneaut (Pennsylvania waters) and Erie ports have contributed well over 90 percent in most years since 1972. Yellow perch have been at least 86 percent of the catch. (2-251) Unlike trends observed for the rest of Lake Erie, no discernable decrease in yellow perch production can be observed for these parts with 1974 and 1976 being years of peak catches since 1972.

Tributaries to Lake Erie Along the South Shore of the Central Basin (East and West of the Proposed Site)

2.836
A number of tributaries drain the rather small watershed area along the south shore of the Central Basin of Lake Erie in the vicinity of the proposed site. Statistical information on each tributary is presented in Table 2-412 while the abundance of macroinvertebrates during the Fall of 1975 are shown in Figure 2-146.

Pennsylvania

Elk Creek

2.837
In Pennsylvania, Elk Creek, and its tributary Little Elk Creek, has the largest drainage basin of those listed. Little Elk Creek is a relatively high gradient stream dropping as much as 60 feet per mile near its mouth. Elk Creek has more moderate gradients, ranging from 20 feet per mile near its headwaters and 30 feet per mile near its mouth. Both of these tributaries have in the past been designated by the State as "first priority Scenic Rivers" for recreational reasons, although they exhibit water quality below State standards (refer to Table 2-412).

2.838
On 24 August 1972, an investigation of Elk Creek by the Erie County Department of Health reported degraded water quality up to at least 200 yards downstream of the Lake City Sewage Treatment Plant, including areas void of benthic macroinvertebrates or, at most, populated by the more facultative species. A selective fish kill of darters, possibly due to residual chlorine, was also noted. The section of stream from I-90 to the Lake City Sewage Treatment Plant was reported to exhibit very good water quality and included pollution-sensitive macroinvertebrates and a wide diversity of fish, including rainbow trout, smallmouth and largemouth bass. (2-252) Although the creek survey was conducted in 1972, the "1974 Fishing and Boating Inventory" conducted by the Pennsylvania Fish Commission indicated

Table 2-412

Selected Tributaries to Lake Erie on the Southeast Shore of the Central Basin

	Tributary To	Drainage Basin in Square Miles (1)(2)	1975 Scenic Rivers Classification (3)	Type of Fishing Provided (4)	Families Represented (4)	Stocked Stream (4)	Fishing Use (4)
Erie County, Pennsylvania							
Walnut Creek	Lake Erie	38.1	20 miles (I:B,R,2)	Coldwater Stream	S,O,Cy,Ca,I,Ce,P	Yes	M
Trout Run	Lake Erie	6.98		Coldwater Stream	S,O,Ca	Yes	H
Elk Creek	Lake Erie	99.4	25 miles (I:B,S,2)	Mixed Stream	S,O,E,Cy,Ca,I,Ce,P	Yes	M
Little Elk Creek	Elk Creek	21.1	6 miles (I:B,S,2)	?	S,O,E,Ca		
Crooked Creek	Lake Erie	20.3		Coldwater Stream		Yes	M
Godfrey Run	Lake Erie			Coldwater Stream	S,O,Ca	Yes	H
Erie/Crawford Counties, Pennsylvania							
Conneaut Creek	Lake Erie	152.0*	21 miles (II,S,2)	Mixed Stream	S,O,E,Cy,Ca,I,Ce,P	Yes	H
Ashtabula County, Ohio							
Ashtabula River	Lake Erie	137.14**					
Grand River	Lake Erie	712.1	Yes				

Keys:
Scenic Rivers Classification
I - top priority, of Statewide significance
A - most urgent need
B - less than immediate concern
II - have some outstanding values, of local or regional significance
R - recreational
S - scenic
2 - stream does not meet WQST, expected to in 0-10 years

Fishing Use
H - High, over 400 man-days/mile/year
M - Medium, 100-400 man-days/mile/year

Species Recorded
S - Salmonidae - Brook, Brown, Rainbow and Lake Trout; Chinook and Coho Salmon
O - Osmeridae - Smelt
E - Esocidae - Chain Pickerel
Cy - Cyprinidae - Carp
Ca - Catostomidae - Suckers
I - Ictaluridae - Bullhead and other Catfish
Ce - Centrarchidae - Bluegill, Pumpkinseed, Rock Bass
P - Percidae - Walleye, Yellow Perch

Table 2-412 (Continued)

* Includes 1.20 sq mi in Ohio, The Gazetteer of Ohio Streams states that between the two states, the total drainage is 191.2 sq. mi.

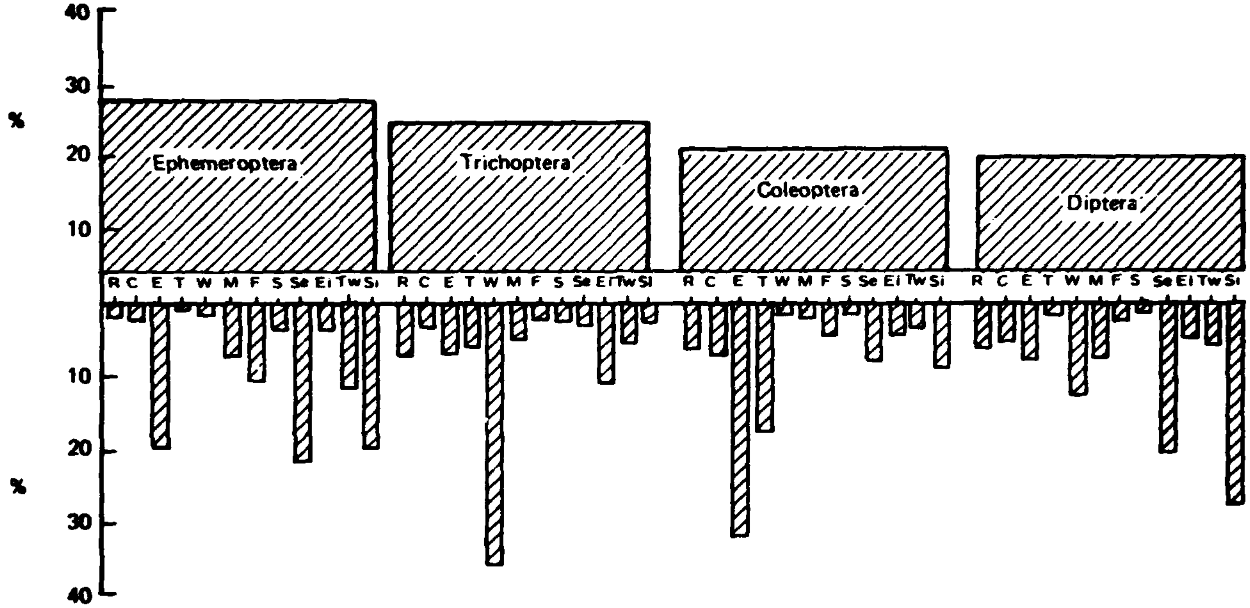
**8.91 miles of the river is in Pennsylvania.

(1) L.C. Shaw and W.F. Bush. Penn. Gazetteer of Streams, Part 1, Bulletin No. 6, Commonwealth of Penn., Department of Environmental Resources, May, 1971.

(2) J.C. Korlizvk (compilation) and O.H. Jefferse (appendix). The Gazetteer of Ohio Streams, Report No. 12, Ohio Water Plan Inventory, 1960.

(3) The Pennsylvania Scenic Rivers Inventory, The Bureau of Resources Programming, Division of Outdoor Recreation and the Pennsylvania Wild and Scenic Rivers Task Force, December 1975.

(4) 1974 Fishing and Boating Inventory Report by County, County Erie, 02/30/75 Report Date, Pennsylvania Fish Commission.



(1)R – Raccoon Creek
C – Crooked Creek
E – Elk Creek
T – Trout Run
W – Walnut Creek
M – Mill Creek
F – Four Mile Creek
S – Six Mile Creek
Se – Seven Mile Creek
Ei – Eight Mile Creek
Tw– Twelve Mile Creek
Si – Sixteen Mile Creek

Source: Masteller, *et al.*, "Biological and Geological Characteristics During August-September of Lake Erie Tributaries of Erie County, Pa.," in, *Proceedings of the Pennsylvania Academy of Science*, 50:54, 1976

FIGURE 2–146 MOST ABUNDANT AQUATIC INSECTS (BY PERCENT) IN AUTUMN IN LAKE ERIE TRIBUTARIES, (1) FOR ALL STREAMS, AND (2) THE PERCENTAGE OF EACH INSECT ORDER IN EACH STREAM SAMPLED

that this degraded water quality may still have been in evidence. In general, Elk Creek supports a wide variety of lake and river fish species, and is considered to be a significant recreational resource.

Walnut Creek

2.839
Walnut Creek is smaller than Elk Creek and exhibits similar gradients. This water course was designated as a "first priority recreational stream" in the 1975 Scenic River Inventory, although State water quality standards have not been met. Walnut Creek was surveyed during four days in February of 1973 by the Erie County Department of Health. Water sampling and benthos collections from near the mouth of Millcreek Township to stations in Summit Township indicate generally good water quality. Minor exceptions occurred in areas downstream from pastureland and downstream from construction sites. Moderately degraded water quality at the upstream stations appeared to be the result of leachate from a landfill and possibly a malfunctioning sewage treatment plant. (2-253) A 1976 survey indicated continued degradation in one upstream section of Walnut Creek (near Robinson Road) attributed to siltation from a landfill and discharges from sewage treatment plants. (2-254) Walnut Creek is classified as a coldwater stream, supporting a wide variety of fish, including anadromous lake species and is a significant recreational fishery.

Conneaut Creek

2.840
Conneaut Creek flows through three counties, two in Pennsylvania and one in Ohio. It is best described as a low gradient stream. The Erie County portion, including a small segment in Ohio, was surveyed by the Erie County Department of Health during a week in September of 1973. Water quality ranging from "good" to "very good" was noted for most sections of this stream and several smaller tributaries. Exceptions were presumed to be the result of inputs from the Albion sewage treatment plant, runoff from pastureland on the East Branch, and runoff from cinder and salt storage piles on Marsh Run. (2-255) The Erie County portion of this water course has a "second priority" Scenic River designation. It supports a population of anadromous lake fish and is an important recreational fishing resource.

Trout Run

2.841
Trout Run, a high gradient stream, drains a small watershed comparable in size to Turkey and Raccoon Creeks, discussed later in this section. A fish hatchery is located near the mouth of this creek and

a stream survey was conducted in October of 1975, prior to its operation. The upstream portions were considered to exhibit generally good water quality, with some evidence of organic enrichment. Unpermitted septic discharges or pasture runoff were suggested as causes. Reaches of the creek about midway between the mouth and the source exhibited degraded water quality with a high residual chlorine and sewage/solids content noted. The lower portions of the stream showed improved water quality, including pollution-sensitive taxa in the benthos collections, although siltation from construction of the hatchery was occurring. (2-256) This is a coldwater stream, supporting lake runs of anadromous fish species and an intensive recreational fishery.

Summary

2.842
The Pennsylvania tributaries to Lake Erie listed in Table 2-411 except Conneaut Creek, are all included in the Fish Commission or Trout Cooperative Salmonid Stocking Program (Conneaut Creek is stocked with trout by the Ohio Division of Wildlife). A 1976 fall survey of Erie County, Lake Erie Tributaries, including those mentioned above, reflected the good water quality, especially in the western tributaries, based on the diversity of species collected (refer to Table 2-413). (2-257)

Ohio

2.843
Drainage to Lake Erie in Ashtabula County occurs, for the most part, through two large low gradient tributaries, the Grand River and Ashtabula Creek. A small section is drained by downstream portions of Conneaut Creek, and several unnamed small tributaries drain a portion of North Kingsville. Other Lake Erie tributaries draining Ashtabula City include Red Brook, Indian Creek, Cowles Creek, Wheeler Creek, and Ashtabula. All are medium gradient streams (averaging 21.2 to 39.4 feet loss in elevation per mile). (2-258) Fifty-six mile reach of the Grand River is included in Ohio's Scenic Rivers program, but does not include the mouth.

Grand River

2.844
Water quality for the Grand River is most severely impacted by industrial and municipal effluents in the downstream 4.9 miles. In addition, a number of municipal sewage treatment plants and several industries discharge into tributaries of this river for a good portion of its length. During 1973 the upstream portions were, for the

Table 2-413

Distribution of Total Collected Fish Fauna from Sampled Tributary Streams East of the Proposed Site

	Raccoon Creek (4)	Crooked Creek (4)	Elk Creek	Trout Run	Walnut Creek	Mill Creek	4-Mile Creek	6-Mile Creek	7-Mile Creek	8-Mile Creek	12-Mile Creek	16-Mile Creek	Total
Petromyzontidae (1)													
Lampetra lamottei					1								1
Salmonidae (2)													
Salmo gairdneri				18*	1							1	20
Salmo trutta			5		2								7
Cyprinidae (18)													
Campostoma anomalum	16	44	137	2	244	38	1	50	27	24		9	592
Clinostomus elongatus			28	3	57			8		66			162
Cyprinus carpio												4	4
Ericymba buccata	14	47	2										63
Hybopsis amblops		1	11		7								19
Nocomis biguttatus					2								2
Nocomis micropogon		3	2		58								63
Notropis atherinoides							1						1
Notropis boops	25	4	2		1								32
Notropis cornutus	15	65	113	24	108	28	1	10		2			356
Notropis hudsonius					1								1
Notropis stramineus		4	8		7								19
Notropis volucellus		1					2						3
Pimephales notatus	4	13	49	3	4								73
Pimephales promelas	3			1	5		2			1		4	16
Rhinichthys atratulus	5	11	165	8	72	42	151	154	73	20	204	319	1224
Rhinichthys cataractae		6	17	3	22		38	11		1	4	74	176
Semotilus atromaculatus	43	19	100	9	78	30	4	5	6	58	37	115	504
Catastomidae (2)													
Catastomus commersonii	4	15	65	20	49	31		9	3	15		3	214
Hypentelium nigricans	3	6	3	1									13
Ictaluridae (3)													
Ictalurus melas											1		1
Ictalurus nebulosus			1										1
Noturus flavus		1	1										2
Gasterosteidae (1)													
Culaea inconstans			6										6
Centrarchidae (7)													
Ambloplites rupestris	12	2	2										16
Lepomis cyanellus		1	3										4
Lepomis gibbosus	13				10			1	3		8		35
Lepomis macrochirus	2	2	40		4			1					49
Micropterus dolomieu	1	5	13		5							11	35
Micropterus salmoides					1								1
Pomoxis nigromaculatus												19	19

Table 2-413 (Continued)

	Raccoon Creek (4)	Crooked Creek (4)	Elk Creek	Trout Run	Walnut Creek	Mill Creek	4-Mile Creek	6-Mile Creek	7-Mile Creek	8-Mile Creek	12-Mile Creek	16-Mile Creek	Total
Percidae (4)													
Etheostoma caeruleum	43	6	33	3	63	4		4	29				185
Etheostoma flabellare	1	1		1	5					1			9
Etheostoma nigrum	4	6	32	3	8			1		1			55
Percina caprodes			1										1
Cottidae (1)													
Cottus bairdii	7	10	6			3		1		2		1	30
Totals													
No. Species	18	23	26	14	24	7	8	12	6	11	5	11	
No. Individuals	215	273	845	99	814	176	200	255	141	191	254	560	4024

Source: Masteller, et al., n, Proceedings of the Pennsylvania Academy of Science, 50:53, 1976.

most part, in compliance with water quality standards. However, the result of a March 1970 survey indicate that a number of areas were devoid of benthic macroinvertebrates and benthos was found, oligochaete and dipteran species were nearly exclusive inhabitants. The area near the Fairport Sewage Treatment Plant was an exception, containing a number of pollution-sensitive organisms. It was suggested in an USEPA report that stream flow carried effluent downstream in this area. However, this might not be representative of present sentence. (2-297)

Ashtabula River

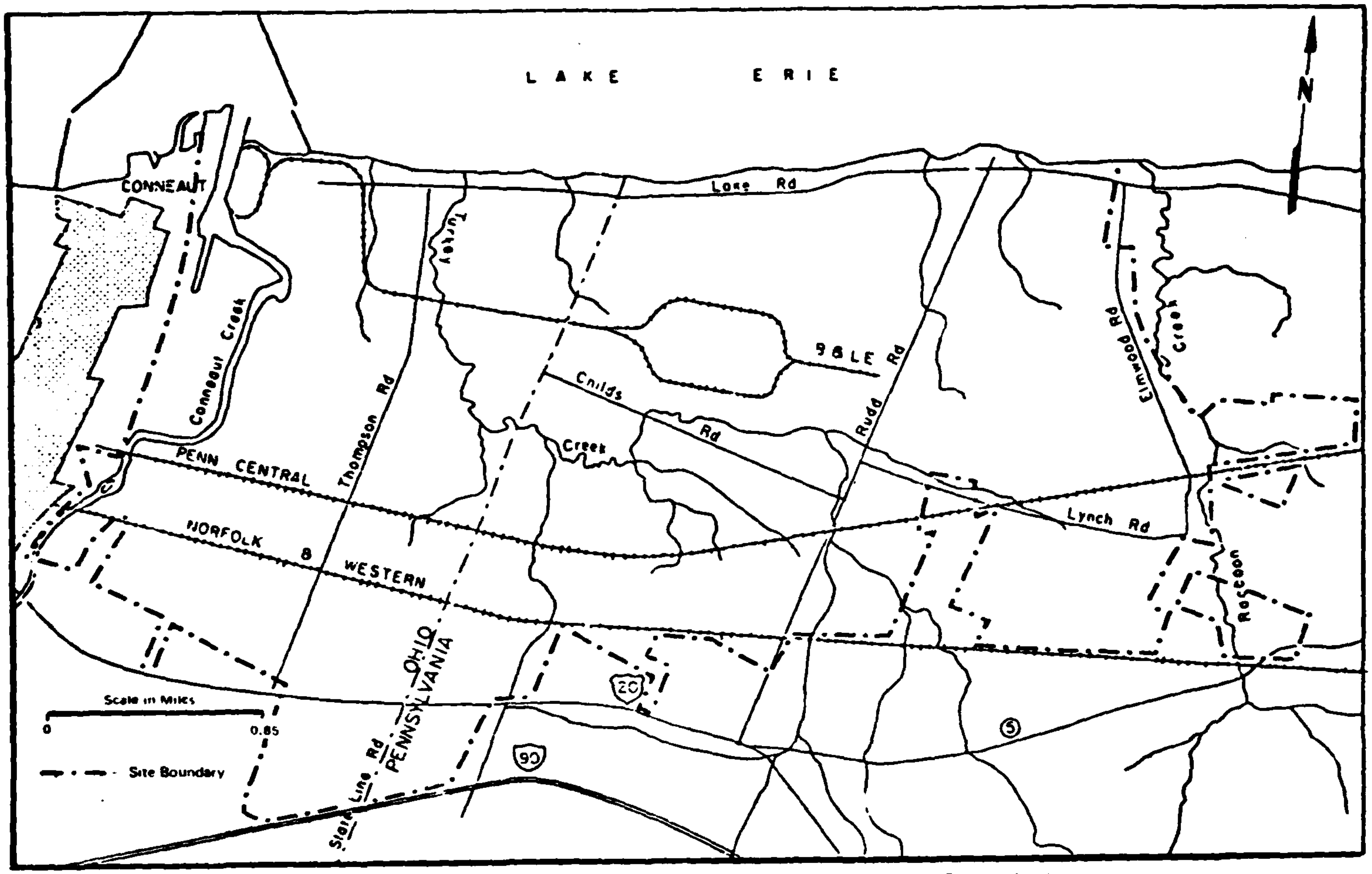
2.845
The mouth of Ashtabula River, including its Fields Brook tributary, exhibits severely degraded water quality due to industrial and municipal wastes. Benthos were sampled in this area in May and June of 1971. These data indicate organic pollution upstream from the confluence of Fields Brook and Ashtabula River since the benthic population consisted mostly of oligochaetes. Benthic organisms were scarce or non-existent in Fields Brook upstream of the Ashtabula River. No benthic organisms were found in the river immediately upstream or downstream of the confluence with Fields Brook. Pollution tolerant organisms were observed further downstream at the mouth of the Ashtabula River. (2-258) Benthic populations of Conneaut Creek were also surveyed in May of 1972 prior to the installation of secondary treatment facilities at the Conneaut sewage treatment plant. Upstream samples showed high diversity and were indicative of high water quality, while harbor samples contained large populations of oligochaetes. (2-258)

Summary

2.846
Conneaut Creek is stocked with salmonids on a yearly basis but no such programs exist for the Grand River nor Ashtabula River at this time. (2-259) Arcola Creek (just outside of the Regional Study Area) and Turkey Creek, on the proposed Lakefront Plant site are also in this salmonid program in addition to being the only two regional streams managed by the ODNR as salmonid beach fishing areas.

Aquatic Resources of the Lakefront Site

2.847
The proposed site for the construction of the Lakefront Steel Plant occupies a 5,500-acre parcel of land on Lake Erie between Conneaut Creek, Ohio, and Raccoon Creek, PA. A map showing the principal aquatic features of the Lakefront site is presented in Figure 2-147.



Source: Aquatic Ecology Associates, "Aquatic and Terrestrial Ecology Studies, First Interim Report." 1977.

FIGURE 2–147 MAP OF THE PRINCIPAL AQUATIC FEATURES OF THE STUDY SITE

a) On-Site Monitoring Program

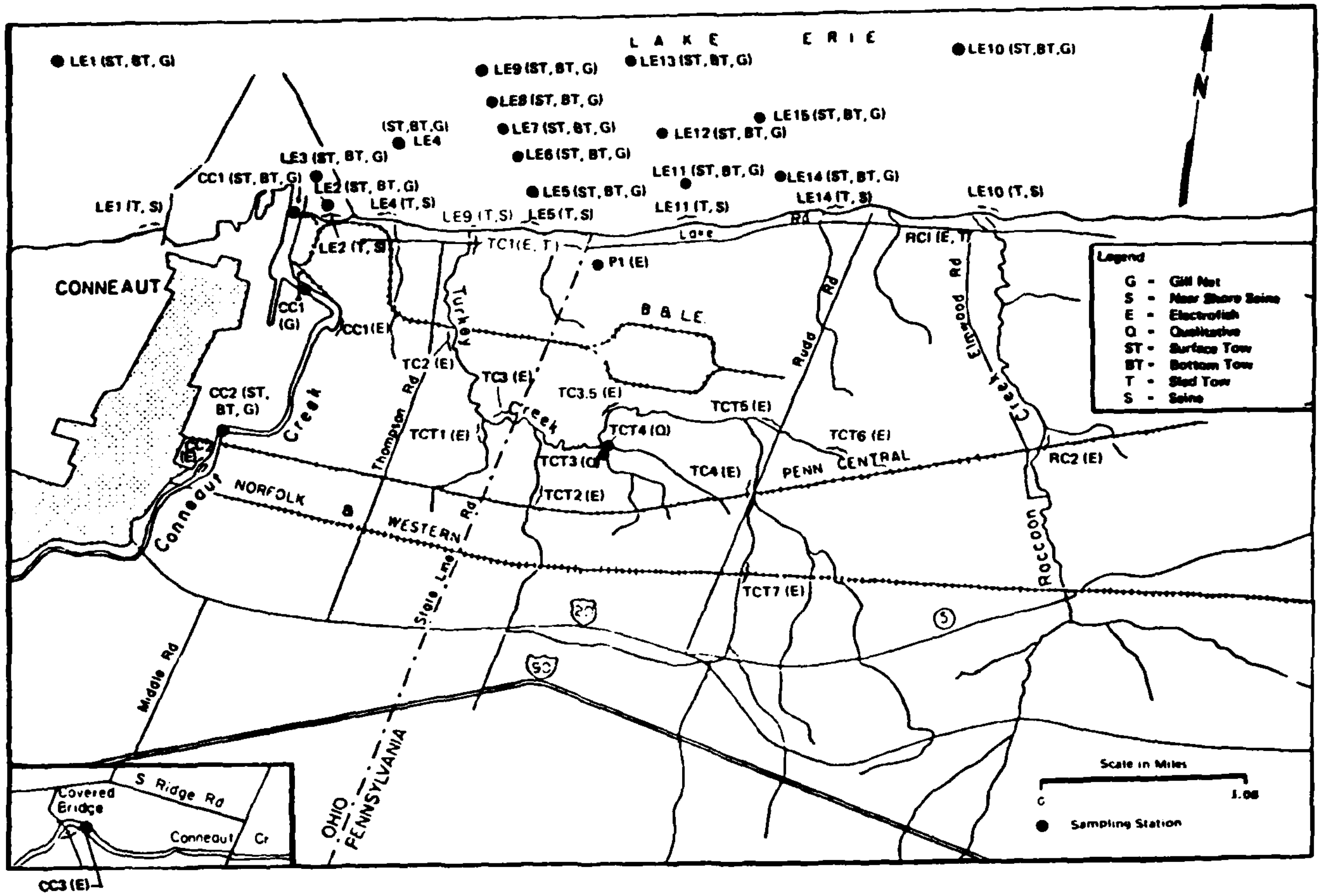
2.848
To characterize the aquatic resources of the Lakefront site a sampling program was instituted by the applicant in March 1977. Data were collected on Lake Erie, Conneaut Creek, Turkey Creek, Raccoon Creek, and several on-site water bodies by Aquatic Ecology Associates, Pittsburgh, PA.

Lake Erie Sampling Stations

2.849
The Lake Erie sampling stations were chosen to examine ambient conditions in those portions of the lake directly by the proposed action. Stations LE1 and LE10 were located at the 30-foot contour to examine offshore aquatic biota in areas relatively removed from the direct influence of Conneaut Creek or its associated harbor facility. Sampling stations were established in the vicinity of the proposed dock expansion site to determine the value of the aquatic resources in this area and the potential influence of Conneaut Creek and harbor water quality on this resource. These stations were designated LE2 and LE3. A separate station LE4 was established to the east of the harbor breakwaters to observe the behavior of eddy currents and to assess the sheltering effect these structures have on the aquatic biota of this nearshore area. Stations LE5 - LE9 were located at the 10, 15, 20, 25, and 30-foot contours along the proposed alignment for the plant intake and discharge.

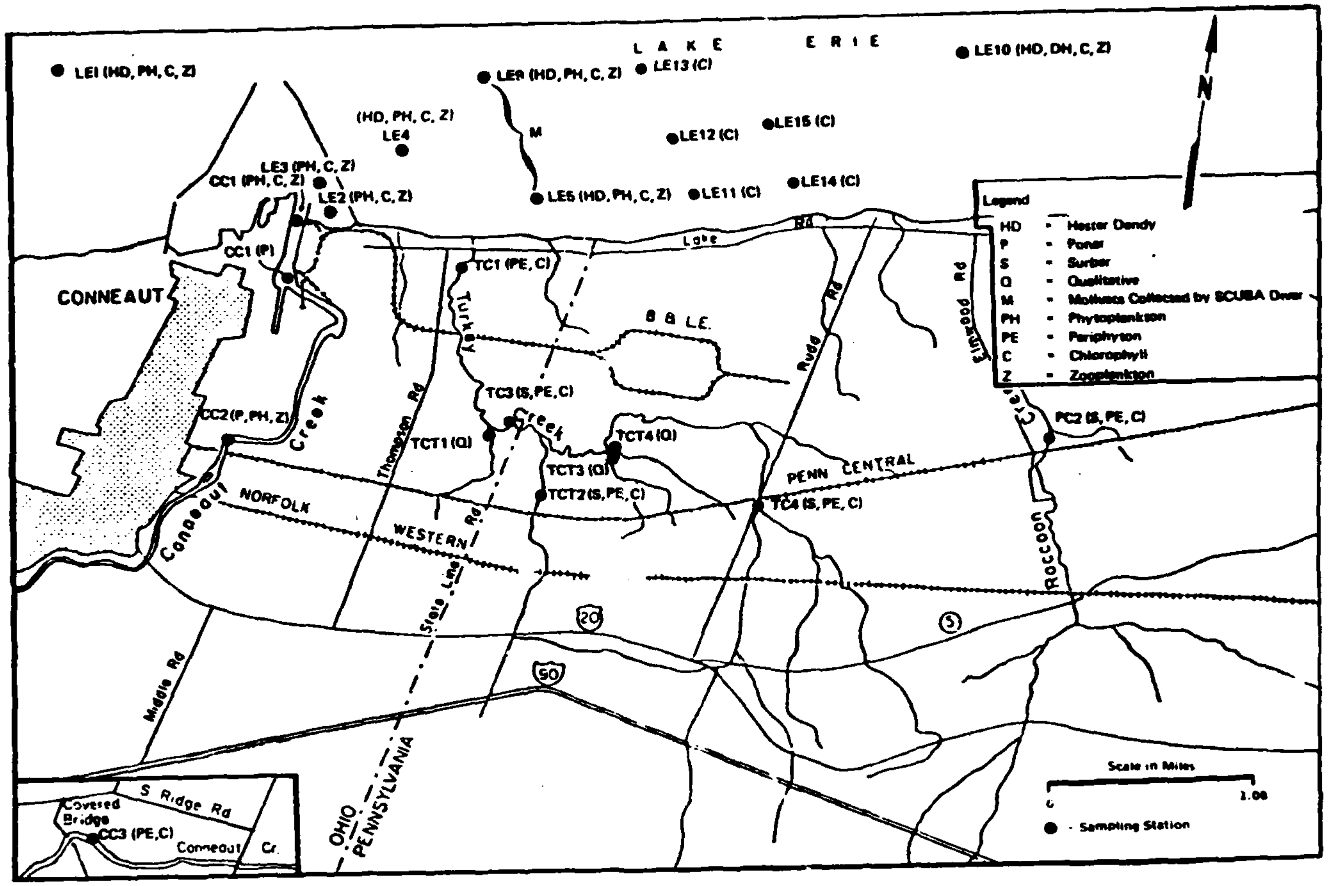
2.850
Beach seining stations were established to characterize the nearshore biota of Lake Erie. One station was located to the west of Conneaut Harbor while a second was established near the site of the proposed dock expansion. Three other stations were established along the Lake Erie shoreline in the vicinity of the proposed intake and outfall.

2.851
The selection of sampling station locations and the overall AEA monitoring program was reviewed by the inter-governmental technical team on 24 June 1977. During this meeting, five additional monitoring stations were added which were designated LE11 through LE15 along with two beach seining stations. A map showing the location of the lake sampling stations for adult fish is presented in Figure 2-148, while the location of macroinvertebrate, zooplankton, phytoplankton, and periphyton sampling stations is shown in Figure 2-149.



Source: Aquatic Ecology Associates

FIGURE 2-148 LOCATION MAP OF STREAM AND LAKE ADULT FISH SAMPLING LOCATIONS AND STREAM AND LAKE ICHTHYOPLANKTON SAMPLING LOCATIONS



Source: Aquatic Ecology Associates

FIGURE 2–149 LOCATION MAP OF MACROINVERTEBRATE, ZOOPLANKTON, PHYTOPLANKTON AND PERIPHYTON SAMPLING LOCATIONS

Conneaut Creek Sampling Station

2.852
Near the mouth of Conneaut Creek there is a sewage treatment plant outfall and a large raw materials storage area containing coke, limestone, and taconite. Station CC-1 was established at the mouth of the creek to examine the ambient water quality and the aquatic biota in this region where sewage effluent and urban and storage pile runoff are introduced. In this manner, the effect of sewage effluent and urban and storage pile runoff could be assessed. However, the proximity of this station to the deep draft navigation channel prevented the setting of nets for any length of time. Therefore, all fish collections were made at the first bend in the creek upstream of CC-1.

2.853
To examine the aquatic biota of Conneaut Creek above the ore storage area and sewage treatment plant outfall Station CC-2 was established. However, urban stormwater runoff does enter the creek at this location. This site contains a small amount of riffle habitat and is situated near an in-stream island.

2.854
Assessment of the aquatic biota of Conneaut Creek upstream of the Conneaut urban and industrial areas was also necessary. Collection of data was accomplished at sampling station CC-3 located near the Ohio-Pennsylvania State line, several miles above the Lakefront site. At this location the creek channel is bordered by a steep bank on one side and a broad flood plain on the other. The creek at CC-3 contains a riffle zone which is composed of bedrock rubble. Downstream of the riffle the creek bottom is scoured to bedrock and beyond this point a large deep pool forms which contains a silt bottom. The location of the Conneaut Creek sampling stations is shown in Figure 2-149.

Turkey Creek Sampling Stations

2.855
To assess the value of Turkey Creek as an aquatic resource, several sampling stations were placed at various locations throughout the watershed. Station TC-1 was established at the mouth. This area is characterized by a broad flood plain which is periodically submerged and a beach composed of sand and rock cobbles. Between the mouth and Lake Road the creek forms a pool approximately 40 feet wide. The creek bank adjacent to the west side of this pool is low and only sparsely vegetated. However, the east bank is higher and supports woody shrubs and trees which provide a minimal amount of shade. At the upstream end of this site the creek bottom is composed of rubble,

mud, or silt, while in the pool area the bottom is predominantly silt. Sand and large cobbles characterize the bottom of Turkey Creek at the mouth.

2.856
The variability of the actual outlet is due to changing or temporary accretion of sand and rubble at the western side of the opening. Higher creek flows in the absence of storms, probably keep the mouth slightly east of the pool location. Sand buildup from the west can cause water to flow eastward along the beach for some distance before entering the lake, as well as narrowing this opening. Thus, pool depth and width upstream from the opening may vary both with runoff levels and the nature of the actual discharge point. Such changes occurred at least three times between late March and late April. With proper wind conditions, seiches have also been observed which result in the entry of lake water into the pool, at least as far upstream as Lake Road.

2.857
A second Station, TC-2, was located upstream of the twin culverts under the old Bessemer and Lake Erie railroad spur. The stream banks vary in elevation but are not usually more than several feet above the creek surface. The tree and shrub growth in the area was dense providing shade throughout most of this reach. Large branches and logs littered the stream channel with the greatest accumulation on the upstream side of the culverts. At this location the stream is three to four feet wide and not more than two feet deep. The bottom substate consists of gravel, some rock fragments and very little silt.

2.858
To characterize the riffle and pool habitat of Turkey Creek a sampling station was established to the west of State Line Road, which designated TC-3. With the exception of the large pool at State Line Road, tree and shrub canopy along this reach is quite dense providing shade throughout the summer months. Bottom substrate in the riffle zone consists of bedrock while in the adjoining pool it is mostly mud. During the late summer another station TC-3.5 was added to obtain data on adult fish, specifically large and smallmouth bass.

2.859
The aquatic biota of selected tributaries to Turkey Creek was also surveyed during the on-site sampling program. One station designated TCT-1 was located on a tributary downstream of TC-3. The tributary flows through a wide tree covered valley, which tends to shade this watercourse throughout the normal growing season. Fallen logs and branches interrupt the flow at numerous locations. A second station,

TCT-2, was established on a tributary which traverses the construction site for the Bessemer and Lake Erie railroad. At this location the creek banks rise approximately 2-10 feet above the water surface and exhibit dense tree and shrub growth. The tributary itself contains several riffle zones, alternating with pools 2-3 feet in depth. Although most sampling was conducted downstream of the culverts the overall effort was broadened to include benthic macroinvertebrate sampling above the railroad construction site.

2.860
Three other tributaries to Turkey Creek were included in this survey. Two of these, TCT-3 and TCT-4 were located in creek channels less than 1.5 feet in width and six inches in depth which meandered through tickets of alder and small trees. A third station TCT-5 was established in the the Turkey Creek tributary west of Rudd Road. The creek channel at this location varied from two feet to 20 feet in width. Bottom substrates consisted of mud which supported a dense growth of aquatic vascular plants. During the months of August and September the tributary above and below this station was extensively sampled in an effort to locate adult bass.

2.861
Another sampling station, TC-4, was established on Turkey Creek in the vicinity of the Conrail tracks, an unpaved road, and a private residence (occupied until the summer of 1977) with a field used by horses. The creek banks in this area consist of grass and herbaceous growth which provides very little shading of the creek channel. Bottom substrate consisted of silt and loose rubble. The location of the Turkey Creek sampling stations is shown in Figure 2-149

Raccoon Creek Sampling Stations

2.862
Sampling was also conducted in Raccoon Creek since it resembled to some extent the conditions encountered in Turkey Creek. Station RC-1 was established at the mouth. At this location, the creek widens north of Lake Road to form a pool then constricts to a narrow channel prior to entering Lake Erie. The outlet is over a sand, gravel, and rocky beach and is fed by wide pool and characterized by a mud-silt bottom. The mouth of the creek is variable for the same reasons that the mouth of Turkey Creek is variable, but to a greater degree. Storms push gravel and sand up along the western side of the opening outlet, moving the actual opening to the east. The adjoining creek bank to the west is steep and tree covered while the eastern bank is low with some tree cover.

2.863
To characterize the upstream portions of Raccoon Creek, Station RC-2 was established to the north of the Conrail Culvert. At this location the banks are heavily vegetated with dense shade provided throughout the growing season. The bottom substrate in the riffle areas consists of sand and gravel with some rock, becoming mostly silt in the pool. The location of each Raccoon Creek sampling station is shown in Figure 2-149.

Investigation of Other On-Site Water Bodies

2.864
The proposed plant site contains several other small tributaries to Lake Erie, several tributaries to Conneaut Creek, and several small ponds. The two tributaries to Conneaut Creek are in the vicinity of the ongoing (1977) construction for expanded raw materials handling operations. Both of these have been diverted and culverted and have experienced heavy siltation. In both cases, the mouths flow over a steep (three to five feet) embankment into Conneaut Creek and there is very little, if any likelihood that fish could migrate from the large creek into these tributaries. Similarly, there are four additional intermittent tributaries to Lake Erie on the site which are shown on the USGS map. Two of these are located in the Ohio portion of the site and two in the Pennsylvania portion. In all cases, they were characterized by low-volume flows late in March and were periodically dry later in 1977. Three of these tributaries enter Lake Erie as trickles of water over rocks and sand on the beach. The fourth tributary entered the lake over a steep embankment. None of these tributaries were included in the sampling program, nor were several other, even smaller tributary streams not shown on the USGS map. One of the larger ponds, labeled P1, was examined qualitatively. This pond was set in the middle of an overgrown, abandoned field and surrounded by alder, willow, and cherry. The pond was about 21 feet deep and characterized by a mud bottom, large aquatic macrophytes, and tadpoles. No fish were collected during the sampling effort of April 1977.

b) Sediment Chemistry

2.865
Sediments collected from Lake Erie, Conneaut Creek, Raccoon Creek, and Turkey Creek were analyzed to determine their chemical quality. Samples collected in the Lake Erie tributaries were taken using a coring device. However, sediment in Lake Erie was collected by scuba equipped divers for the most part although one sample was collected with a ponar dredge. The procedures followed for the storage and eventual analysis of the sediment samples are the same as those reported in Standard Methods for the Analysis of Water and Wastewater

(1975) U.S. Environmental Protection Agency Guidance Manuals, and American Society for Testing of Materials publication (1977). The results of the applicant's sediment analysis are presented in Tables 2-414 and 2-415. For comparative purposes the EPA guidelines for classification of Great Lakes Harbor sediments is presented in Table 2-416. No data were reported on volatile solids, polychlorobipheynls (PCB), and chemical oxygen demand (COD).

c) Lake Erie and Lower Reaches of Conneaut Creek - Aquatic Biota

Phytoplankton

2.866
Of the 216 taxa of phytoplankton identified near the site, 82 were green algae and 84 were diatoms. Fourteen taxa of blue-green algae, six golden algae, 11 euglenoids, 17 dinoflagellates, and two cryptomonads were also found. However, most of the 216 taxa were rare so that only 35 taxa accounted for 92.4 percent of phytoplankton biomass during the study (Table 2-417). While green algae and diatoms constituted nearly equal percentages (37 and 38 percent, respectively) of the phytoplankton taxa, they composed 13 and 41 percent, respectively of the total phytoplankton biomass. Cryptomonads composed only one percent of the taxa but 22 percent of the total biomass. Number of taxa is a useful form of phytoplankton data but only when it is remembered that some algae, such as green algae, have been thoroughly studied by taxonomists while others, such as the cryptomonads, are virtually unknown.

2.867
Biomass density of total phytoplankton occurred in the normal pattern of a spring peak followed by a period of comparatively low density in early summer, another peak in fall, and minimum densities in winter. Low temperatures and minimal sunlight commonly limit phytoplankton growth in winter, especially under ice. As these restraints disappear in spring, considerable growth occurs until nutrients are exhausted. Species able to utilize the forms of nutrients available gradually increase during the summer minimum. The fall maximum dies as winter conditions return.

2.868
Figure 2-150 presents the seasonal succession of phytoplankton divisions near the site. Diatoms appear to be the overall dominants while the other five groups are each abundant at one or more times of the year. Blue-green algae appear to have been most abundant in October, but on 8 July 1977, a visible bloom of blue-green algae was noted. Since the major portion of the bloom appeared after the June sampling and disappeared before the August sampling, it does not show itself in Figure 2-150. Green algae increased through spring and

Table 2-414

Sediment Chemistry for Lake Erie (LE) and the Two Downstream Stations in Conneaut Creek (CC), May 17 and 18, 1977[(1)]

(All values expressed as mg/kg dry weight)

	Station								
Parameter	CC1	CC2	LE1	LE2	LE3	LE4	LE5	LE9	LE10
NO_2-N	2	1	1	1	1	1	1	1	1
NO_3-N	6	5	2	3	2	4	2	1	4
NH_3-N	6	5	8	4	10	10	10	8	10
PO_4-P	10	4	10	10	10	10	10	10	10
TKN	80	146,000	168,000	50	50,000	190,000	120	20	207,000
Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cr	28	11	44	25	22	30	11	22	35
Cu	32	14	29	8	16	24	8	4	27
Fe-Total	43,000	38,600	38,100	31,700	25,900	32,300	13,600	15,100	36,900
Ni	41	19	50	19	26	37	31	34	49
Pb	28	16	42	10	17	30	90	80	38
Zn	120	65	170	110	91	130	60	69	170
TOC	5,500	880	5,500	1,400	3,900	4,200	1,400	700	5,400
Oil & Grease	100	20	80	60	100	60	60	100	100
Hg	<1	2	6	<1	5	3	3	<1	<1

(1) Sediments sampled at CC2 on May 18, 1977; remaining stations sampled on May 17, 1977.

Source: Aquatic Ecology Associates, "Aquatic and Terrestrial Ecology Studies: Lakefront Plant, Conneaut, Ohio," 3/3 - 8/15/77.

Table 2-415

Bottom Sediment Chemistry for Lake Erie (LE) and Lower Conneaut Creek (CC), August 15 and 17, 1977(1)

(All values expressed as mg/kg dry weight)

Parameter	Station LE1	LE2	LE3	LE4	LE5	LE9	LE10	CC1	CC2
NO_2-N	1	1	1	1	2	2	1	2	100
NO_3-N	4	4	5	4	6	5	3	4	10
NH_3-N	80	80	100	60	70	100	80	100	20
PO_4-P	170	240	110	200	150	200	100	180	170
TKN	550	780	780	350	350	1,400	300	1,500	90
Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cr	9	14	12	10	7	17	3	18	13
Cu	14	25	26	15	12	26	22	35	38
Fe-Total	30,700	34,000	31,600	28,200	21,700	31,500	33,500	41,900	31,300
Ni	26	25	31	27	21	38	34	37	36
Pb	15	24	27	11	7	28	14	42	39
Zn	160	100	94	40	80	130	71	140	130
TOC	2,700	3,500	4,700	2,900	2,900	4,100	3,500	7,600	9,900
Oil & Grease	60	1,000	100	40	120	60	40	100	600
Hg	<1	<1	<1	<1	<1	<1	<1	<1	<1

(1) Lake Erie samples taken August 15, 1977 and Lower Conneaut Creek, August 17, 1977.

Source: Aquatic Ecology Associates, "Aquatic and Terrestrial Ecology Studies: Lakefront Plant, Conneaut, Ohio," 3/3-8/15/77.

Tab e 2-6 Guidelin. for the Poll tion Cla sification of Great .akes Harbor Sediments

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Guidelines for the evaluation of Great Lakes harbor sediments, based on bulk sediment analysis, have been developed by Region V of the U. S. Environmental Protection Agency. These guidelines, developed under the pressure of the need to make immediate decisions regarding the disposal of dredged material, have not been adequately related to the impact of the sediments on the lakes and are considered interim guidelines until more scientifically sound guidelines are developed.

The guidelines are based on the following facts and assumptions:

a. Sediments that have been severely altered by the activities of man are most likely to have adverse environmental impacts.

b. The variability of the sampling and analytical techniques is such that the assessment of any sample must be based on all factors and not on any single parameter with the exception of mercury and polychlorinated biphenyls (PCB's).

c. Due to the documented bioaccumulation of mercury and PCB's, rigid limitations are used which override all other considerations.

Sediments are classified as heavily polluted, moderately polluted, or nonpolluted by evaluating each parameter measured against the scales shown below. The overall classification of the sample is based on the most predominant classification of the individual parameters. Additional factors such as elutriate test results, source of contamination, particle size distribution, benthic macroinvertebrate populations, color, and odor are also considered. These factors are interrelated in a complex manner and their interpretation is necessarily somewhat subjective.

The following ranges used to classify sediments from Great Lakes harbors are based on compilations of data from over 100 different harbors since 1967.

Table 2-416 (Continued)

	Nonpolluted	Moderately Polluted	Heavily Polluted
Volatile Solids (percent)	5	5-8	8
COD (mg/kg dry weight)	40,000	40,000-80,000	80,000
TKN (mg/kg dry weight)	1,000	1,000-2,000	2,000
Oil and Grease (Hexane Solubles) (mg/kg dry weight)	1,000	1,000-2,000	2,000
Lead (mg/kg dry weight)	40	40-60	60
Zinc (mg/kg dry weight)	90	90-200	200

The following supplementary ranges used to classify sediments from Great Lakes harbors have been developed to the point where they are usable but are still subject to modification by the addition of new data. These ranges are based on 260 samples from 34 harbors sampled during 1974 and 1975.

	Nonpolluted	Moderately Polluted	Highly Polluted
Ammonia (mg/kg dry weight)	75	75-200	200
Cyanide (mg/kg dry weight)	0.10	0.10-0.25	0.25
Phosphorus (mg/kg dry weight)	420	420-650	650
Iron (mg/kg dry weight)	17,000	17,000-25,000	25,000
Nickel (mg/kg dry weight)	20	20-50	50
Manganese (mg/kg dry weight)	300	300-500	500
Arsenic (mg/kg dry weight)	3	3-8	8
Cadium (mg/kg dry weight)	*	*	6
Chromium (mg/kg dry weight)	25	25-75	75
Barium (mg/kg dry weight)	20	20-60	60
Copper (mg/kg dry weight)	25	25-50	50

*Lower limits not established

Table 2-41C (Continued)

The guidelines stated below for mercury and PCB's are based upon the best available information and are subject to revision as new information becomes available.

Methylation of mercury at levels _ 1 mg/kg has been documented (1, 2). Methyl mercury is directly available for bioaccumulation in the food chain.

Elevated PCB levels in large fish have been found in all of the Great Lakes. The accumulation pathways are not well understood. However, bioaccumulation of PCB's at levels _ 10 mg/kg in fathead minnows has been documented (3).

Because of the known bioaccumulation of these toxic compounds, a rigid limitation is used. If the guideline values are exceeded, the sediments are classified as polluted and unacceptable for open lake disposal no matter what the other data indicate.

	Polluted
Mercury	_1 mg/kg dry weight
Total PCB's	_10 mg/kg dry weight

The pollutional classification of sediments with total PCB concentrations between 1.0 mg/kg and 10.0 mg/kg dry weight will be determined on a case-by-case basis.

a. Elutriate test results.

The elutriate test was designed to simulate the dredging and disposal process. In the test, sediment and dredging site water are mixed in the ratio of 1:4 by volume. The mixture is shaken for 30 minutes, allowed to settle for one hour, centrifuged, and filtered through a 0.45 u filter. The filtered water (elutriate water) is then chemically analyzed.

A sample of the dredging site water used in the elutriate test is filtered through a 0.45 u filter and chemically analyzed.

A comparison of the elutriate water with the filtered dredging site water for like constituents indicates whether a constituent was or was not released in the test.

The value of elutriate test results are limited for overall pollutional classification because they reflect only immediate release to the water column under aerobic and near neutral pH conditions. However, elutriate test results can be used to confirm releases of

toxic materials and to influence decisions where bulk sediment results are marginal between two classifications. If there is release or nonrelease, particularly of a more toxic constituent, the elutriate test results can shift the classification toward the more polluted or the less polluted range, respectively.

b. Source of sediment contamination.

In many cases the sources of sediment contamination are readily apparent. Sediments reflect the inputs of paper mills, steel mills, sewage discharges, and heavy industry very faithfully. Many sediments may have moderate or high concentrations of TKN, COD, and volatile solids yet exhibit no evidence of man made pollution. This usually occurs when drainage from a swampy area reaches the channel or harbor, or when the project itself is located in a low lying wetland area. Pollution in these projects may be considered natural and some leeway may be given in the range values for TKN, COD, and volatile solids provided that toxic materials are not also present.

c. Field observations.

Experience has shown that field observations are a most reliable indicator of sediment condition. Important factors are color, texture, odor, presence of detritus, and presence of oily material.

Color. A general guideline is the lighter the color the cleaner the sediment. There are exceptions to this rule when natural deposits have a darker color. These conditions are usually apparent to the sediment sampler during the survey.

Texture. A general rule is the finer the material the more polluted it is. Sands and gravels usually have low concentrations of pollutants while silts usually have higher concentrations. Silts are frequently carried from polluted upstream areas, whereas, sand usually comes from lateral drift along the shore of the lake. Once again, this general rule can have exceptions and it must be applied with care.

Odor. This is the odor noted by the sampler when the sample is collected. These odors can vary widely with temperature and observer and must be used carefully. Lack of odor, a beach odor, or a fishy odor tends to denote cleaner samples.

Detritus. Detritus may cause higher values for the organic parameters COD, TKN, and volatile solids. It usually denotes pollution from natural sources. Note: The determination of the "naturalness" of a sediment depends upon the establishment of a natural organic source and a lack of man made pollution sources with low values for

metals and oil and grease. The presence of detritus is not decisive in itself.

Oily material. This almost always comes from industry or shipping activities. Samples showing visible oil are usually highly contaminated. If chemical results are marginal, a notation of oil is grounds for declaring the sediment to be polluted.

d. Benthos.

Classical biological evaluation of benthos is not applicable to harbor or channel sediments because these areas very seldom support a well balanced population. Very high concentrations of tolerant organisms indicate organic contamination but do not necessarily preclude open lake disposal of the sediments. A moderate concentration of oligochaetes or other tolerant organisms frequently characterizes an acceptable sample. The worst case exists when there is a complete lack or very limited number of organisms. This may indicate a toxic condition.

In addition, biological results must be interpreted in light of the habitat provided in the harbor or channel. Drifting sand can be a very harsh habitat which may support only a few organisms. Silty material, on the other hand, usually provides a good habitat for sludgeworms, leeches, fingernail clams, and perhaps, amphipods. Material that is frequently disturbed by ship's propellers provides a poor habitat.

Source: USEPA, Region V, April, 1977

Table 2-417 Percent Composition by Biomass of Phytoplankton Divisions and Abundant Taxa (More than 1% of Total Phytoplankton Biomass on Any Date) in Lake Erie and Lower Conneaut Creek near the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, May 1977 through April 1978. (Mean of 18 Samples on Each Date.)

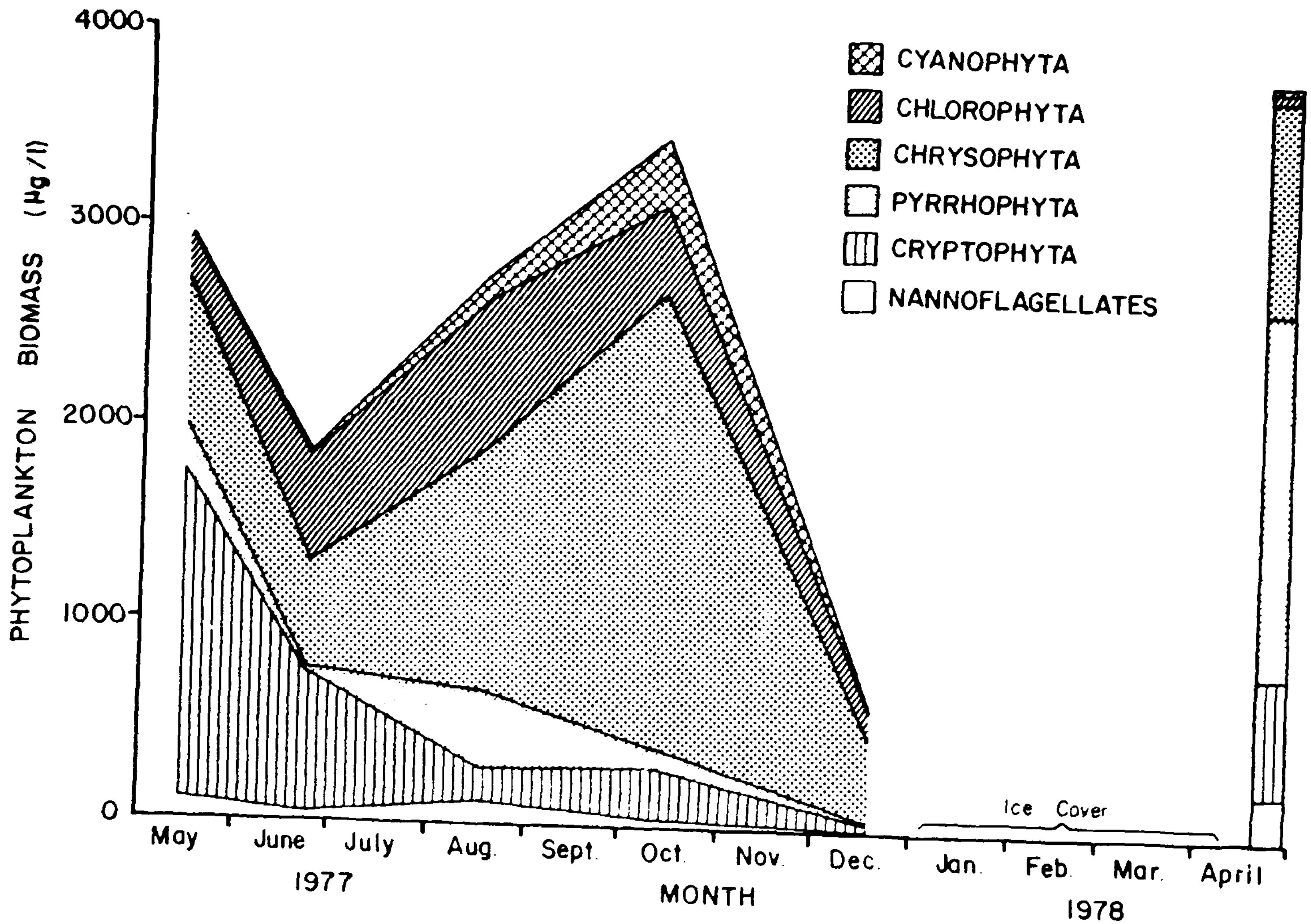
	DATE						
Taxa	5/13	6/22	8/16	10/11	12/18	4/24	Overall
Cyanophyta - total	0.6	0.5	4.6	10.1	1.0	0.5	3.5
Oscillatoria limnetica	0.1	-	0.1	3.8	0.4	0.5	1.0
Aphanizomenon flos-aquae	0.5	0.4	2.2	3.5	0.6	0.1	1.4
Anabaena flos-aquae	-	0.1	1.9	0.6	-	-	0.5
Chlorophyta - total	7.5	29.4	27.4	11.8	9.2	1.4	13.3
Gloeocystis planctonica	0.1	1.9	3.0	1.2	*	-	1.0
Ulothrix subconstricta	-	2.8	-	-	*	*	0.3
Cladophora glomerata	-	-	-	-	1.1	0.1	*
Pediastrum duplex	0.2	0.4	0.4	1.2	0.4	-	0.4
Chlorella vulgaris	1.9	6.8	3.1	1.4	0.2	0.3	2.1
Ankistrodesmus falcatus	1.9	0.5	*	0.1	0.2	0.1	0.9
Scenedesmus quadricauda	0.2	7.2	0.5	0.7	2.3	0.1	1.2
Crucigenia quadrata	*	1.8	*	0.1	*	0.1	0.3
Closterium aciculare	*	0.2	1.0	0.3	1.9	-	0.3
Closterium venus	*	0.9	*	1.3	0.2	-	0.4
Cosmarium formulosum	-	1.1	4.4	0.4	*	-	1.0
Staurastrum paradoxum	-	0.5	7.5	0.4	0.8	-	1.5
Chrysophyta - total	26.4	28.0	43.7	66.2	80.5	28.2	41.0
Melosira islandica	-	-	-	-	-	9.3	2.3
Melosira varians	0.3	0.4	0.5	0.4	1.3	*	0.3
Stephanodiscus astraea	1.9	1.0	0.8	0.1	13.5	1.8	1.6
Stephanodiscus binderanus	7.9	0.1	*	-	1.3	0.9	1.8
Stephanodiscus niagarae	7.7	12.8	27.4	5[illegible]	55.8	0.8	22.5
Coscinodiscus rothii	-	0.4	1.9	6.8	1.7	-	2.0
Small centrics	3.6	8.0	0.9	1.9	0.9	1.7	2.7
Diatoma tenue elongatum	1.1	-	-	-	-	0.6	0.4
Asterionella formosa	0.1	0.1	0.1	0.1	1.3	1.1	0.4
Fragilaria capucina	-	-	5.3	1.1	1.7	1.1	1.5
Fragilaria crotonensis	0.1	1.0	5.2	0.2	*	2.3	1.7
Navicula viridula	0.6	0.2	0.1	*	0.2	5.5	1.5
Euglenophyta - total	0.2	0.6	0.2	*	0.2	0.1	0.2
Pyrrhophyta - total	5.8	1.4	13.9	2.5	1.1	48.5	16.4
Gymnodinium helveticum	5.0	0.1	-	-	0.4	0.2	1.0
Peridinium aciculiferum	-	-	0.1	-	*	46.1	11.4
Peridinium pusillum	*	-	0.6	-	0.8	1.0	0.4
Diplosalis acuta	-	0.5	0.1	2.0	-	-	0.5
Ceratium hirundinella	-	0.5	13.0	0.5	-	-	2.5

Table 2-417 (Continued)

Taxa	5/13	6/22	8/16	10/11	12/18	4/24	Overall
	DATE						
Cryptophyta - total	55.9	37.8	6.2	7.7	7.7	15.2	22.2
Rhodomonas minuta	30.7	7.2	3.9	2.3	2.3	7.6	9.9
Cryptomonas erosa	25.2	30.5	2.3	5.4	5.3	7.6	12.2
Nannoflagellates	3.5	2.3	4.2	1.3	0.4	6.1	3.5
Total Biomass (μg/l)	2952	1878	2776	3470	532	3814	2571

*Taxon was present but it composed less than 0.05% of total phytoplankton biomass.

Figure 2-150 Seasonal Succession of Major Phytoplankton Divisions in Lake Erie and Lower Conneaut Creek near the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, May 1977 through April 1978. (Mean of All Samples on Each of Six Sampling Dates.)



decreased through fall. Dinoflagellates peaked in August and in spring. Cryptomonads declined gradually form a spring maximum.

2.869
Studies of the central basin of Lake Erie in 1970 showed a similar succession of phytoplankton divisions. In April, diatoms rather than dinoflagellates were abundant, but a May peak of cryptomonads declined slowly through June (somewhat later near midlake). Blue-green algae peaked in July and green algae in August and September, as they did near the site. Diatoms were generally abundant but had their greatest densities in fall. While the spring dinoflagellate peak had not been noted, the August peak occurred with even greater densities than near the site.

2.870
Variations in the phytoplankton among the nine sampling stations were mostly what could be expected from the physical characteristics of the stations. Station CC2 was usually an unproductive location with detached periphytic diatoms and little true plankton. The harbor stations had high biomass densities due to species that flourish in shallow, calm water. Station CC1 had some of the characteristics of both station CC2 and the harbor stations. The offshore stations were similar to each other and dominated by truly planktonic species. Stations LE4 and LE5 were highly variable, resembing the harbor stations in May and the offshore stations in June and October. In August, station LE4 was similar to the offshore stations, and station LE5 was similar to the harbor stations. Apparently, these two stations are easily affected by changes in direction of wind and current. Figure 2-151 presents the distribution of phytoplankton biomass over each of the nine sampling stations shown in Figure 2-149. Temporal peaks of individual species can be ascertained from Table 2-417.

Chlorophyll a and Pheophytin a

2.871
Chlorophyll a is the basic pigment of photosynthesis, and its concentration is a measure of standing crop or the potential for photosynthetic production. Pheophytin a is a decomposition product of chlorophyll a and its concentration is a measure of the death rate of the phytoplankton.

2.872
Distribution of chlorophyll a followed the distribution of phytoplankton biomass on most of the five dates on which both parameters were monitored (Figure 2-151 and Table 2-418). The ratio of phytoplankton to chlorophyll a was approximately 600 to 1. Station CC2 on all dates and station CC1 in October and December had noticeably

Figure 2-151 Distribution of Phytoplankton Biomass, Pheophytin *a*, and Chlorophyll *a* over 9 Sampling Stations in Lake Erie (LE) and Lower Conneaut Creek (CC) near the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, June 1977 through April 1978. (Means of Surface and Bottom Values.)

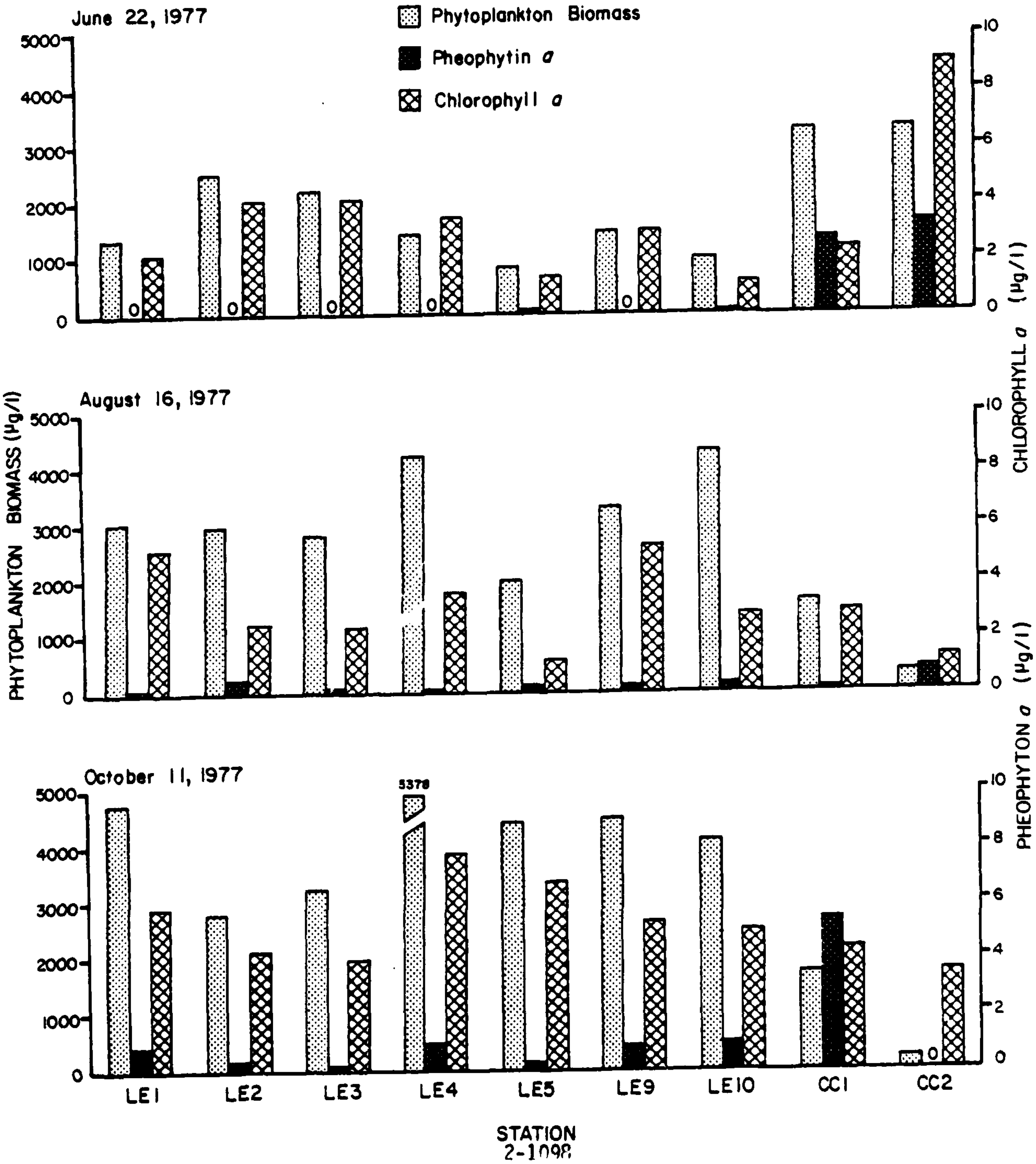
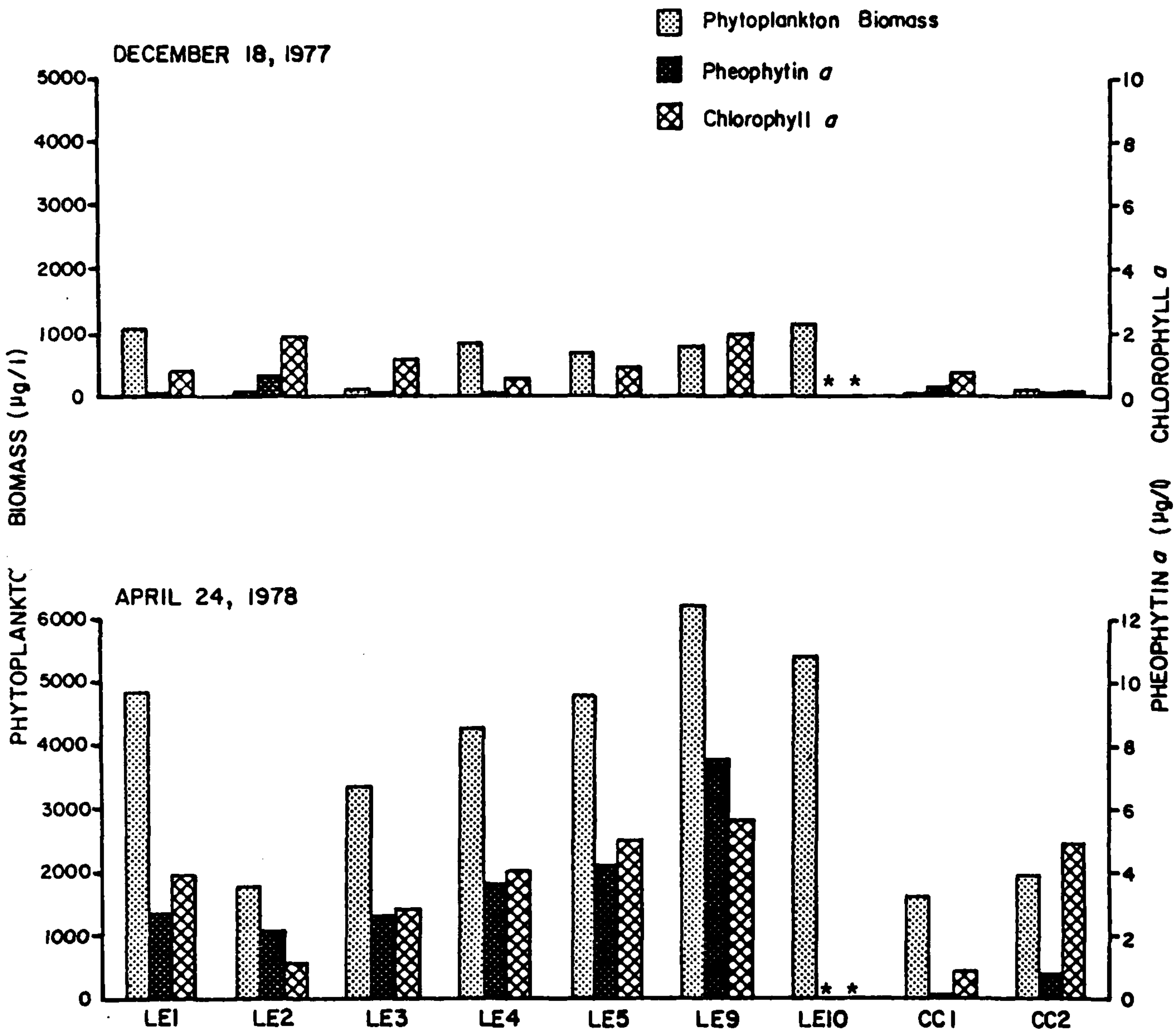


Figure 2-151 (Continued)



Means of Sampling Dates

	LE1	LE2	LE3	LE4	LE5	LE9	LE10	CC1	CC2
Biomass	3013	2026	2345	3229	2567	3263	3200	1645	1165
Pheophyton a	0.72	0.77	0.60	0.95	0.98	1.74	*	1.63	1.36
C[illegible]rophyll a	3.64	2.73	2.90	3.88	3.07	4.22	*	2.28	3.72

*Sample could not be analyzed due to high turbidity.

Table 2-418 Chlorophyll *a* Concentrations (μg/l) in Lake Erie (LE) and Lower Conneaut Creek (CC) near the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, April 1977 through April 1978. (S = Surface, B = Bottom, X = No sample taken, T = Sample too turbid for analysis.)

Station	Depth	DATE 4/26	6/22*	8/16	10/11	12/17-18	4/24	Mean	Partial Mean**
LE1	S	0.00	2.25	4.50	5.63	1.76	4.78	3.15	4.29
	B	0.00	2.25	5.91	6.19	0.00	3.10	2.91	4.36
LE2	S	1.87	3.66	2.25	4.50	3.16	1.41	2.81	2.96
	B	0.94	4.50	2.81	3.75	0.53	0.70	2.20	2.94
LE3	S	6.83	5.06	1.41	4.22	2.34	3.16	3.84	3.46
	B	5.28	3.10	3.38	3.75	0.00	2.53	3.01	3.19
LE4	S	1.88	3.10	3.37	8.12	1.17	6.47	4.02	5.26
	B	0.70	3.66	3.94	7.32	0.00	1.69	2.88	4.15
LE5	S	2.81	1.97	1.41	7.03	0.70	4.50	3.07	3.73
	B	0.94	0.84	0.94	6.47	1.17	5.63	2.66	3.47
LE9	S	1.41	2.81	3.94	5.63	1.17	8.16	3.85	5.14
	B	2.81	2.81	6.75	5.06	2.81	3.10	3.89	4.43
LE10	S	0.00	0.28	3.94	5.35	2.81	T		
	B	0.94	1.97	1.69	4.50	T	T		
LE11	S	X	3.75	1.13	5.35	X	4.78		3.75
	B	X	3.28	2.53	5.35	X	5.35		4.13
LE12	S	X	6.30	1.97	5.86	X	5.63		4.94
	B	X	2.99	3.10	2.81	X	4.22		3.28
LE13	S	X	0.00	3.94	3.66	X	11.54		4.78
	B	X	0.00	2.25	5.91	X	4.50		3.16
LE14	S	X	3.28	2.25	6.75	X	5.63		4.48
	B	X	1.58	1.41	6.47	X	5.91		3.84
LE15	S	X	3.75	7.03	7.60	X	5.35		5.93
	B	X	1.69	5.91	8.72	X	4.22		5.14
CC1	S	0.56	3.66	3.38	3.75	0.62	0.00	2.00	2.70
	B	1.69	1.13	2.46	5.16	0.70	1.87	2.17	2.66
CC2	S	1.97	5.06	1.05	3.75	0.00	5.35	2.86	3.80
	B	1.97	12.66	1.41	3.28	0.18	4.45	3.99	5.45
Mean			3.04	3.07	5.43		4.39		
Partial Mean***		1.81	3.25	3.03	5.19	1.12	3.56		

*June collections at stations LE11 through LE15 were made on June 30, 1977.
**Dates 4/26 and 12/17-18 are excluded.
***Stations LE11 through LE15 are excluded.

lower ratios, which were probably due to inwash of terrestrial plant fragments containing chlorophyll a. In December 1977, the effect extended to the harbor stations, verifying the broader influence of Conneaut Creek at that time. The only instance of consistently high phytoplankton: chlorophyll ratios was the April 1978 sampling at the lake stations. The high proportion of dinoflagellates, which use other pigments besides chlorophyll a for photosynthesis, and the lower proportion of green algae, which use mostly chlorophyll a, could account for this. Over all dates, chlorophyll a density was usually higher at the surface than at the bottom.

2.873
Pheophytin a concentrations were generally low on 22 June and 16 August 1977, when summer temperatures would have kept its decomposition rate high (Figure 2-151 and Table 2-419). Higher pheophytin a values occurred in October, suggesting that a fairly large portion of the phytoplankton was dying at that time. The low levels of pheophytin a in December can only mean that the fall die-off of the phytoplankton had been completed a week or more before sampling. Very high pheophytin a values in April 1977 and April 1978 were probably due to resuspension of the previous fall's dead plankton from the bottom by the wind. Bottom densities were generally higher than surface densities on all dates. Highest pheophytin a values in other months than April occurred in Conneaut Creek, but no other distribution patterns among stations were obvious.

Periphyton

2.874
Periphyton are generally defined as algae that grow attached to rocks and other available substrates in shallow water. Density and composition of periphytic algae can vary greatly within a very small area since factors such as substrate, current, and sunlight can be extremely variable over small distances. Even a single rock will commonly exhibit considerable variation over its surface (Ruttner, 1971). Factors such as water temperature, nutrients, and scouring rates have a more generalized effect and can limit periphytic population potential for a given area. Discharge of heated, enriched, or chemically contaminated water can cause a shift in species composition towards certain blue-green algae and diatoms (EPA, 1974).

2.875
Of the 179 taxa of periphyton identified at the site, 125 were diatoms although 29 of those were found only in Hyrax mounts and cannot be positively said to have been alive when collected. Thirteen blue-green algae, 33 green algae, one golden alga, five euglenoids and two cryptomonads were also found. On a biomass basis, diatoms completely dominated the samples although the green alga Cladophora

Table 2-419 Pheophytin *a* Concentrations (µg/l) in Lake Erie (LE) and Lower Conneaut Creek (CC) near the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, April 1977 through April 1978. (S = Surface, B = Bottom, X = No sample taken, T = Sample too turbid for analysis.)

		DATE							
Station	Depth	4/26	6/22*	8/16	10/11	12/17-18	4/24	Mean	Partial Mean**
LE1	S	0.00	0.00	0.23	0.28	0.00	4.28	0.80	1.20
	B	0.00	0.00	0.00	1.29	0.12	1.04	0.41	0.58
LE2	S	0.09	0.00	0.51	0.00	1.27	2.04	0.65	0.64
	B	2.34	0.00	0.73	0.84	0.00	2.25	1.03	0.96
LE3	S	0.00	0.00	0.37	0.05	0.00	2.25	0.44	0.67
	B	1.13	0.00	0.00	0.19	0.16	2.98	0.74	0.79
LE4	S	2.72	0.00	0.17	1.06	0.00	6.33	1.71	1.89
	B	3.72	0.00	0.00	0.96	0.16	0.87	0.95	0.46
LE5	S	1.78	0.00	0.40	0.00	0.00	5.74	1.32	1.54
	B	1.03	0.14	0.21	0.42	0.00	2.84	0.77	0.90
LE9	S	6.80	0.00	0.20	0.68	0.00	8.19	2.64	2.27
	B	3.42	0.00	0.34	1.04	0.00	6.95	1.96	2.08
LE10	S	2.63	0.11	0.00	0.96	0.00	T		
	B	4.31	0.00	0.68	1.01	T	T		
LE11	S	X	0.00	0.06	0.37	X	1.52		0.49
	B	X	0.00	0.03	0.17	X	0.37		0.14
LE12	S	X	0.00	0.39	1.20	X	3.83		1.36
	B	X	0.00	0.25	3.69	X	2.87		1.70
LE13	S	X	0.10	1.58	5.99	X	8.75		4.10
	B	X	0.10	0.11	2.36	X	2.19		1.19
LE14	S	X	0.00	1.29	0.34	X	1.86		0.87
	B	X	0.00	2.73	0.00	X	0.39		0.78
LE15	S	X	0.51	0.00	0.00	X	2.34		0.71
	B	X	0.00	0.00	0.00	X	3.26		0.82
CC1	S	4.56	3.43	0.17	2.16	0.69	0.16	1.86	1.48
	B	3.43	2.03	0.00	8.62	0.00	0.00	2.35	2.66
CC2	S	2.95	7.74	0.67	0.00	0.12	1.35	2.14	2.44
	B	3.55	2.70	0.89	0.00	0.00	0.14	1.21	0.93
Mean			0.60	0.43	1.20		2.88		
Partial Mean***		2.43	0.90	0.31	1.07	0.15	2.96		

*June collections at stations LE11 through LE15 were made on June 30, 1978.
**Dates 4/26 and 12/17-18 are excluded.
***Stations LE11 through LE15 are excluded.

glomerata and a few blue-green algae were occasionally abundant. The rare nannoflagellates found were probably Ochromonas spp.

2.876
Sampling was conducted in Conneaut Creek, Turkey Creek, and Raccoon Creek, see Figure 2-149. Both artificial and natural substrates were sampled in May and July 1977. Analysis of these samples showed large and variable differences between the two substrates. While variation among sample replicates was sometimes large, as is normal for periphyton, the artificial substrate samples exceeded this variation and could not be considered representative of the actual periphyton community. Thus, taxa found an artificial substrate are not included in Table 2-420 which lists species of periphyton and their mean biomass densities at each sampling station.

Zooplankton

2.877
Zooplankton are the animal component of plankton usually suspended in the water column and dependent on water movements. Freshwater plankton are dominated by four major groups: Protozoa, Rotifera, and the two subclasses of Crustacea, the Copepoda, and Cladocera (water fleas). (Zooplankton do not include the subclass Ostracoda since they are bottom dwellers only caught incidentally in the zooplankton nets.) Zooplankton constitute one of the lower trophic levels in an aquatic community and are an important food resource for many larval and planktivorous adult fish.

2.878
Distribution of zooplankton is influenced by abiotic limitations - trace elements, dissolved organic matter, pH, dissolved oxygen, morphological features of the water body, currents, turbidity and temperature - and biotic interactions. Most species are eurytopic existing under a wide range of environmental conditions. The indicator value of individual species is, therefore, limited somewhat to extreme eutrophic or oligotrophic types and is useful for water bodies of intermediate trophic characteristics (Gannon and Stemberger, 1978). The community associations formed are a particularly useful estimation of the limnological character of a water body. This is less a result of certain indicator species and is more due to the simultaneous occurrence of several forms which might also be found in different types of water.

2.879
The zooplankton community was sampled every two months from April 1977 to April 1978 with the exception of February. Sampling stations are shown in Figure 2-149. The mean number of individuals and

Table 2-420 - Mean Biomass Densities (ug/cm^2) of Periphyton Divisions and Abundant Tax (More Than Two Percent of Mean Total Biomass of Any Sampling Date) on Natural Substrates.

Station CC3

Taxa	5/12	7/6	8/31	10/27	3/30
Cyanophyta - total	*	224	174	360	26
Phormidium minnesotense	-	23	24	357	17
Calothrix braunii	-	12	-	-	-
Calothrix breviarticulata	-	187	-	-	-
Chlorophyta - total	530000	105	368	211	98
Palmella mucosa	-	9	333	54	22
Stigeoclonium sp.	-	23	34	-	-
Cladophora glomerata	530000	-	-	157	75
Pediastrum duplex	-	25	-	-	-
Pediastrum tetras	-	15	-	-	-
Cosmarium granatum	-	12	-	-	-
Chrysophyta - total	*	99	6622	2242	1100
Melosira varians	-	4	5326	740	59
Cyclotella meneghiniana	-	9	28	4	1
Diatoma vulgare	-	-	128	47	-
Meridion circulare	-	-	-	-	26
Fragilaria vaucheriae	-	-	-	4	189
Cocconeis pediculus	*	3	219	-	14
Cocconeis placentula	-	7	50	91	3
Achnanthes minutissima	-	40	190	361	2
Gomphonema angustatum	*	-	-	-	25
Gomphonema parvulum	-	-	146	49	-
Cymbella affinis	-	-	47	132	-
Cymbella sinuata	-	**	20	163	30
Cymbella tumida	-	-	182	21	-
Navicula cryptocephala	-	8	45	60	26
Navicula viridula	-	5	-	26	550
Nitzschia dissipata	-	**	4	401	70
Nannoflagellates	-	**	-	3	1
Total Biomass	530000	429	7165	2816	1224
Total No. Taxa	5	44	33	34	35
Diversity Index	<0.10	3.42	1.83	3.51	3.08
No. Samples Averaged	1	3	3	3	3

*Density of taxon could not be accurately measured but appeared less than 1% of total biomass.

**Taxon was present but its mean biomass was less than 0.5 $\mu g/cm^2$.

Station TC1

Taxa	5/12	7/6	8/31	10/27	12/8	3/30
Cyanophyta - total	2	10	-	11	30	2
Phormidium minnesotense	2	-	-	*	21	2
Lyngbya epiphytica	-	-	-	11	7	*
Chlorophyta - total	*	-	*	*	54	1
Cladophora glomerata	-	-	-	-	52	-
Chrysophyta - total	66	2317	201	103	229	481
Cyclotella meneghiniana	*	109	-	-	-	-
Synedra ulna	1	-	-	25	28	-
Achnanthes minutissima	2	379	1	1	24	5
Rhoicosphenia curvata	2	-	5	2	5	-
Gomphonema angustatum	5	-	-	-	-	403
Gomphonema olivaceum	26	-	-	-	60	6
Gomphonema parvulum	*	7	15	2	33	-
Cymbella minuta	3	31	-	2	2	1
Cymbella tumida	2	772	-	2	29	-
Amphipleura pellucida	-	54	-	1	-	-
Navicula cryptocephala	9	109	55	20	8	19
Navicula rhynchocephala	1	-	16	-	-	-
Navicula salinarum	-	254	-	-	1	-
Navicula symmetrica	-	-	17	2	-	-
Navicula viridula	7	-	19	9	10	12
Nitzschia dissipata	-	82	9	22	25	13
Nitzschia palea	1	46	29	2	-	-
Nitzschia sigma	-	140	-	-	-	-
Nitzschia tryblionella	-	-	5	-	-	-
Surirella angustata	2	-	5	4	-	-
Surirella ovata	5	229	11	3	-	1
Cryptophyta - total	5	-	-	1	-	-
Cryptomonas erosa	5	-	-	1	-	-
Nannoflagellates	*	-	-	*	1	2
Total Biomass	73	2327	201	116	314	485
Total No. Taxa	24	17	32	34	22	19
Diversity Index	3.11	3.12	3.50	3.54	3.49	1.20
No. Samples Averaged	1	1	4	3	3	3

*Taxon was present but its mean biomass was less than 0.5 $\mu g/cm^2$.

Station TC3

Taxa	5/12	7/6	8/31	10/27	12/8	3/30
Cyanophyta - total	-	10	6	86	36	15
Oscillatoria subbrevis	-	-	-	4	14	10
Phormidium minnesotense	-	-	*	64	15	4
Lyngbya epiphytica	-	-	4	14	8	1
Chlorophyta - total	48	-	1	32	29	90
Cladophora glomerata	48	-	-	28	28	89
Chrysophyta - total	971	1140	278	229	171	31
Cyclotella meneghiniana	6	102	6	1	*	-
Meridion circulare	-	-	-	3	-	9
Synedra ulna	11	-	3	62	6	-
Achnanthes minutissima	6	97	2	5	6	4
Rhoicosphenia curvata	-	164	-	1	21	-
Gomphonema olivaceum	496	-	-	-	1	-
Gomphonema parvulum	-	-	1	5	54	-
Cymbella minuta	30	8	-	11	1	-
Cymbella prostrata	-	43	-	-	-	-
Cymbella tumida	46	347	5	-	14	-
Navicula cryptocephala	65	106	75	40	7	1
Navicula rhynchocephala	-	-	22	-	-	-
Navicula salinarum	-	26	-	-	-	-
Navicula viridula	277	107	75	20	21	5
Caloneis bacillum	-	-	18	12	-	1
Nitzschia dissipata	2	55	5	40	29	8
Nitzschia palea	8	14	18	5	-	-
Nitzschia sigma	-	35	-	-	7	-
Surirella angustata	-	-	12	9	-	-
Cryptophyta - total	-	-	-	2	-	-
Nannoflagellates	1	-	-	3	1	1
Total Biomass	1020	1150	284	352	237	137
Total No. Taxa	17	21	43	35	23	17
Diversity Index	2.20	3.28	3.45	3.78	3.57	2.05
No. Samples Averaged	1	1	3	3	3	3

*Taxon was present but its mean biomass was less than 0.5 $\mu g/cm^2$.

Station TC4

Taxa	5/12	7/6	8/31	10/27	12/8	3/30
Cyanophyta - total	23	-	2	92	55	171
Phormidium minnesotense	23	-	-	33	50	166
Lyngbya epiphytica	-	-	1	58	5	2
Chlorophyta - total	-	2	3	131	2173	46
Palmella mucosa	-	2	1	15	10	25
Draparnaldia judayi	-	-	-	-	147	-
Cladophora glomerata	-	-	-	116	2016	21
Chrysophyta - total	3438	501	209	1217	165	726
Melosira varians	-	45	50	-	-	*
Cyclotella meneghiniana	24	58	5	11	-	-
Meridion circulare	-	-	-	3	1	72
Synedra ulna	40	-	2	337	8	-
Cocconeis pediculus	-	22	-	-	-	-
Cocconeis placentula	8	20	16	6	1	2
Achnanthes lanceolata	-	1	10	1	-	17
Achnanthes minutissima	86	18	26	233	48	262
Rhoicosphenia curvata	19	199	-	-	2	16
Gomphonema parvulum	-	9	41	23	6	-
Cymbella minuta	6	6	9	24	2	2
Cymbella sinuata	1	2	5	22	27	34
Cymbella tumida	-	20	-	-	-	-
Gyrosigma acuminatum	-	14	-	-	-	-
Navicula cryptocephala	88	17	27	314	2	2
Navicula rhynchocephala	4	-	9	-	-	-
Navicula salinarum	-	6	-	61	1	-
Navicula viridula	3017	10	3	52	16	251
Nitzschia dissipata	20	1	1	78	8	30
Cymatopleura solea	-	16	-	-	-	-
Cryptophyta - total	-	2	-	2	-	-
Nannoflagellates	1	*	-	13	*	3
Total Biomass	3462	504	215	1434	2393	945
Total No. Taxa	20	35	23	38	25	28
Diversity Index	1.01	3.34	3.33	3.41	1.09	2.95
No. Samples Averaged	1	2	3	3	3	4

*Taxon was present but its mean biomass was less than 0.5 $\mu g/cm^2$.

Table 2-420 Cont.

Station TCT2

Taxa	DATE AND STATION 8/31 TCT2	10/27 TCT2	12/8 TCT2	3/30 TCT2	3/30 Above TCT2
Cyanophyta - total	0.38	13.81	0.12	0.79	3.88
Phormidium minnesotense	0.03	0.24	0.03	0.33	0.60
Lyngbya epiphytica	0.05	12.43	0.10	0.37	3.28
Chlorophyta - total	0.02	-	0.64	-	58.50
Stigeoclonium sp.	-	-	-	-	58.50
Cladophora glomerata	-	-	0.64	-	-
Chrysophyta - total	20.46	137.22	5.00	10.95	442.77
Melosira varians	16.00	-	-	-	-
Meridion circulare	-	0.60	-	2.28	34.89
Synedra ulna	0.01	7.31	-	-	3.06
Achnanthes minutissima	*	0.63	0.14	1.97	4.11
Gomphonema angustatum	-	-	-	6.24	370.67
Gomphonema parvulum	-	5.90	0.80	-	-
Amphora ovalis	-	-	1.71	-	-
Cymbella microcephala	-	4.28	0.11	0.01	7.58
Cymbella minuta	-	23.99	0.12	-	-
Cymbella tumida	0.97	-	-	-	-
Frustulia rhomboides	-	-	0.16	-	-
Navicula cryptocephala	0.39	13.83	0.06	0.05	-
Navicula rhynocephala	0.49	-	-	-	-
Navicula symmetrica	1.09	12.51	0.41	-	-
Nitzschia dissipata	0.05	17.23	0.18	0.26	2.33
Nitzschia linearis	-	6.65	-	-	-
Nitzschia palea	0.36	6.98	-	-	-
Surirella angustata	0.67	26.45	1.16	-	14.97
Surirella ovata	0.16	4.56	-	-	-
Euglenophyta - total	-	1.11	-	-	-
Cryptophyta - total	-	0.89	-	-	-
Nannoflagellates	-	0.90	-	0.11	2.11
Total Biomass	20.86	153.94	5.76	11.84	507.26
Total No. Taxa	20	27	17	13	14
Diversity Index	1.94	3.74	3.06	2.02	1.51
No. Samples Averaged	3	3	3	3	1

*Taxon was present but its mean biomass was less than 0.005 μg/cm².

Station RC2

Taxa	DATE 5/12	7/6	8/31	10/27	12/8	3/30
Cyanophyta - total	*	*	2	47	55	8
Lyngbya epiphytica	-	-	2	43	19	-
Chlorophyta - total	1	2	2	8	61	12
Palmella mucosa	-	1	1	1	58	11
Cladophora glomerata	-	1	-	7	3	-
Chrysophyta - total	2404	24	852	1270	1583	2221
Melosira varians	-	-	88	-	-	-
Cyclotella meneghiniana	-	1	9	2	-	-
Cocconeis placentula	-	6	3	1	-	-
Rhoicosphenia curvata	4	2	-	2	193	-
Gomphonema olivaceum	17	-	-	10	104	328
Amphora perpusilla	-	-	13	*	1	102
Cymbella sinuata	-	*	11	1	5	73
Gyrosigma acuminatum	-	3	-	-	-	-
Neidium dubium	-	2	-	-	-	-
Navicula cryptocephala	231	1	190	231	264	140
Navicula radiosa	54	3	3	*	2	-
Navicula rhynocephala	-	-	90	-	-	-
Navicula symmetrica	-	-	19	2	-	-
Navicula viridula	2023	1	229	922	886	1487
Nitzschia dissipata	7	*	51	77	66	57
Nitzschia palea	7	*	51	*	1	1
Nitzschia sigma	10	1	-	-	-	-
Surirella angustata	-	1	15	-	-	-
Euglenophyta - total	23	-	-	-	-	-
Nannoflagellates	-	*	-	5	4	12
Total Biomass	2428	26	855	1329	1703	2253
Total No. Taxa	22	34	34	29	24	18
Diversity Index	1.05	3.93	3.35	1.56	2.62	1.78
No. Samples Averaged	1	6	3	3	3	3

*Taxon was present but its mean biomass was less than 0.5 ug/cm².

percent composition on each sampling date is presented in Table 2-421. The seasonal abundance of the four major zooplankton groups is presented in Figure 2-152.

2.880
Of the six sampling dates, rotifers dominated zooplankton populations on 26 April 1977 (79.4 percent), 11 October 1977 (55.0 percent), and 24 April 1978 (73.7 percent). On the other three sampling dates, dominance varied with protozoans comprising 79.1 percent of the total community on 16 August 1977, cladocerans 55.8 percent on 22 June 1977, and copepods 49.4 percent of the total population on 18 December 1977. Over the year, rotifers were the most abundant group sampled and protozoans were second in total number. In general, total numbers per liter for all zooplankton were low in winter, started to rise in April and reached a peak in June. Total numbers per liter and reached a peak in June. Total numbers per liter of the major groups generally corresponded to the cycle shown by the entire community (Figure 2-152).

2.881
Spatial distributions of zooplankton by sampling site and depth are presented in Appendix C of the applicant's submitted Aquatic Ecological Study prepared by Aquatic Ecology Associates, Inc. In general, species diversity was similar between all sampling stations except CC1 and CC2 in lower Conneaut Creek. The lower number of species and individuals collected at these stations has been attributed to their lotic nature. Also, on several dates, stations LE2 and LE3 exhibited fewer numbers of species and individuals. This decrease is presumably a reflection of the fluctuating influence of Conneaut Creek. Open-lake stations such as LE1, LE9, and LE10 had a higher number of zooplankton per liter than the harbor stations on almost every date. On 22 June 1977, protozoan and rotifers were higher at the harbor station and on 24 April 1978, rotifers were again higher. Total numbers per liter on both dates, however, still showed the open-lake stations with more zooplankters than the harbor.

2.882
In regards to distribution by depth, sampling results supported the hypothesis that zooplankton exhibit a photonegative response. Although copepods (primarily immature forms) did not show a consistent photokinetic response, the majority of protozoa, cladocerans, and rotifers did appear more abundantly at lower depths throughout the study period.

Benthic Macroinvertebrates

2.883
Aquatic macroinvertebrates are animals large enough to be seen by the unaided eye and can be retained by a U.S. Standard No. 30 sieve

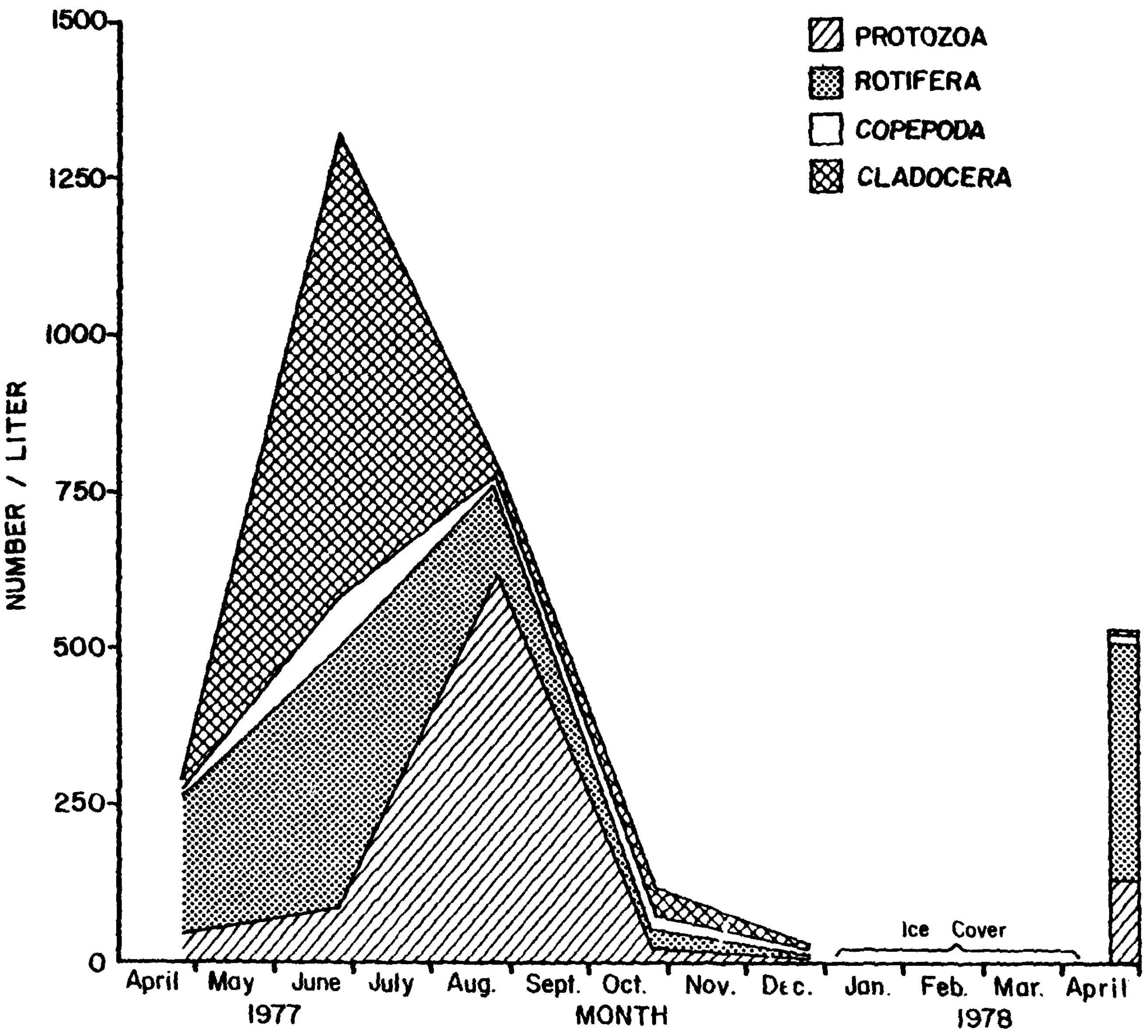
Table 2-421 Comparison of Mean No./Liter of All Samples for Abundant Taxa (More than 1% of Total Zooplankton) in Lake Erie and Lower Conneaut Creek near the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April 26, June 22, August 16, October 11, December 18, 1977 and April 24, 1978.

	DATE											
	4/26/77		6/22/77		8/16/77		10/11/77		12/18/77		4/24/78	
Species	Mean No./l	%	Mean No./l	%	Mean No./l	%	Mean No./l	%	Mean No./l	%	Mean No./l	%
Protozoa												
Actinophrys sp.	-	-	-	-	550.51	70.1	0.74	1.1	-	-	-	-
Bursaridium sp.	22.74	8.2	-	-	-	-	-	-	-	-	-	-
Codonella cratera	-	-	35.28	2.7	-	-	5.25	7.6	0.82	4.4	-	-
Difflugia lobostoma	-	-	-	-	39.82	5.1	1.01	1.5	0.55	3.0	-	-
Difflugia oblonga	-	-	-	-	-	-	1.26	1.8	-	-	-	-
Epistylis plicatilis	-	-	-	-	-	-	1.68	2.4	-	-	-	-
Metacineta sp.	-	-	-	-	-	-	-	-	-	-	21.88	4.2
Sphaerophrya sp.	-	-	-	-	-	-	-	-	-	-	19.21	3.7
Strobilidium gyrans	-	-	33.89	2.6	-	-	-	-	-	-	-	-
Thecacineta sp.	14.58	5.3	-	-	11.86	1.5	5.53	8.0	-	-	-	-
Vorticella microstoma	-	-	-	-	-	-	0.85	1.2	-	-	74.89	14.4
Total Protozoans	45.31	16.4	85.28	6.5	621.59	79.1	17.72	25.5	1.90	10.3	125.57	24.2
Rotifera												
Asplanchna priodonta	24.46	8.1	-	-	9.30	1.2	1.82	2.6	2.31	12.5	157.70	30.4
Brachionus calyciflorus	4.59	1.7	-	-	-	-	-	-	-	-	-	-
Chromogaster ovalis	-	-	-	-	13.04	1.7	-	-	-	-	-	-
Collotheca sp.	-	-	-	-	-	-	4.21	6.1	-	-	-	-
Keratella cochlearis	16.50	6.0	259.72	19.6	73.25	9.3	5.88	8.5	1.92	10.4	-	-
Keratella quadrata	6.67	2.4	-	-	-	-	1.14	1.7	0.50	2.7	8.52	1.6
Notholca squamula	-	-	-	-	-	-	-	-	-	-	199.73	38.5
Polyarthra dolichoptera	87.55	31.6	48.19	3.6	-	-	2.11	3.1	-	-	-	-
Polyarthra euryptera	-	-	-	-	-	-	1.95	2.8	-	-	-	-

Table 2-421 (Continued)

Species	4/26/77 Mean No./l	4/26/77 %	6/22/77 Mean No./l	6/22/77 %	8/16/77 Mean No./l	8/16/77 %	10/11/77 Mean No./l	10/11/77 %	12/18/77 Mean No./l	12/18/77 %	4/24/78 Mean No./l	4/24/78 %
Rotifera (cont'd)												
Polyarthra vulgaris	77.48	28.0	68.33	5.2	21.07	2.7	19.99	28.8	0.33	1.7	-	-
Trichocerca similis	-	-	-	-	13.99	1.8	-	-	-	-	-	-
Total Rotifers	219.98	79.4	414.58	31.3	150.50	19.1	38.13	55.0	5.48	29.7	382.54	73.7
Copepoda												
Cyclops bicuspidatus thomasi	-	-	-	-	-	-	-	-	0.32	1.7	-	-
Cyclops sp. juv.	-	-	47.85	3.6	-	-	1.64	2.4	3.10	16.8	-	-
Diaptomus oregonensis	-	-	-	-	-	-	1.17	1.7	0.25	1.3	-	-
Diaptomus sp. juv.	-	-	-	-	-	-	1.89	2.7	-	-	-	-
Nauplii	8.29	3.0	33.11	2.5	-	-	2.52	3.6	5.14	27.8	9.53	1.8
Total Copepods	10.38	3.7	84.88	6.4	8.53	1.1	8.08	11.7	9.13	49.4	10.62	2.0
Cladocera												
Bosmina coregoni	-	-	77.77	5.9	-	-	1.30	1.9	0.57	3.1	-	-
Bosmina longirostris	-	-	638.05	48.3	-	-	0.95	1.4	1.02	5.5	-	-
Chydorus sphaericus	-	-	-	-	-	-	1.20	1.7	-	-	-	-
Daphnia galeata mendotae	-	-	-	-	-	-	-	-	0.27	1.4	-	-
Daphnia retrocurva	-	-	19.80	1.5	-	-	0.83	1.2	-	-	-	-
Total Cladocerans	1.27	0.5	737.71	55.8	5.10	0.7	5.39	7.8	1.95	10.6	0.22	0.1
Total Individuals/l	276.94	100	1322.45	100	785.72	100	69.32	100	18.46	100	518.95	100
Total No. Species	51		49		64		50		47		43	
Diversity Index	2.96		2.66		1.97		4.07		3.53		2.46	

Figure 2-152 Seasonal Succession of Zooplankton Divisions in Lake Erie and Lower Conneaut Creek, near the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, April 1977 through April 1978. (Mean of All Samples on Each Date.)



(28 meshes per inch, 0.595 mm openings) and live at least part of their life cycles within or upon available substrates in aquatic habitat. Any available substrate may provide suitable habitat including bottom sediments, submerged logs, debris, pilings, pipes, conduits, vascular aquatic plants, or filamentous algae. They occupy virtually all trophic levels and a well balanced ecosystem may include omnivors, carnivors and herbivors.

2.884
A total of 94 taxa of benthic macroinvertebrates were identified from samples collected in Lake Erie near the proposed U.S. Steel Lakefront Plant site between July 1977 and April 1978. The average number of benthic organisms per square meter of substrate at each station for each sampling period is presented in Tables 2-422 and 2-423. Sampling was conducted with Ponar dredges and Hester Dendy artificial substrate samplers (see Figure 2-149).

Lake Erie

2.885
Two distinctive habitats were sampled in Lake Erie. Stations L2 and LE3 were representative of a harbor habitat and stations LE1, LE4, LE5, LE9, and LE10 were representative of an open water habitat. Species composition of these two habitats was distinctly different. The benthic community at the harbor stations was composed primarily of oligochaetes and chironomids. The open water benthic community was comprised primarily of aquatic insects, molluscs, and crustaceans.

2.886
In general, aquatic oligochaetes are common in mud and debris substrate of stagnant waters and tend to dominate in fine sediment zones which are organically enriched/polluted. The abundant number of oligochaetes (80 percent) found in Conneaut Harbor, stations LE2 and LE3, has been attributed to the harbors lentic nature, siltaceous substrate and high oil concentrations within the sediments (315 ppm).

2.887
Oligocheate fauna found at station LE2 were comprised of 20 taxa while that of station LE3 were comprised of 25 taxa. The mean number of oligochaetes per square meter was consistently greater at LE3 than at LE2 over the entire study period.

2.888
Stations LE1, LE4, LE5, LE9, and LE10 which were located in open water area exhibited minimal differences in species composition. Oligochaetes were rarely collected outside of Conneaut Harbor and were represented in extremely low numbers. Diptera, Amphipoda,

Table 2-422 Average Number of Benthic Macroinvertebrates per Square Meter of Substrate in Lake Erie (LE), near the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, July 7, 1977 through December 20, 1977. (P = Ponar, HD = Hester Dendy)

STATION

Taxa	LE1 HD 7/7	LE1 HD 9/1	LE1 HD 10/27	LE1 HD 12/20	LE2 P 7/13	LE2 P 9/1	LE2 P 10/24	LE2 P 12/20	LE3 P 7/13	LE3 P 9/1	LE3 P 10/24	LE3 P 12/20	LE4 HD 7/7	LE4 HD 9/1	LE4 HD 10/28	LE5 HD 7/7	LE5 HD 9/1	LE5 HD 10/27	LE5 HD 12/20	LE9 HD 7/7	LE9 HD 9/1	LE9 HD 10/27	LE9 HD 12/20	LE10 HD 7/7	LE10 HD 9/1	LE10 HD 10/27	LE10 HD 12/20
Oligochaeta																											
Aulodrilus americanus	-	-	-	-	51	26	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aulodrilus limnobius	-	-	-	-	64	2563	961	-	-	487	263	156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Aulodrilus pigueti	-	-	-	-	19	333	128	-	38	461	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aulodrilus pluriseta	-	-	-	-	38	243	-	-	1294	1614	564	128	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilyodrilus templetoni	-	-	-	-	32	-	-	4	410	115	-	743	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus cervix	-	-	-	-	32	-	-	-	1320	846	154	1153	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus hoffmeisteri	-	-	-	-	397	-	-	6	2716	2409	-	4395	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Limnodrilus maumeensis	-	-	-	-	-	64	-	-	3716	2102	26	269	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus udekemianus	-	-	-	-	-	-	-	-	1884	1217	128	513	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peloscolex freyi	-	-	-	-	314	-	-	-	-	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamothrix moldaviensis	-	-	-	-	435	-	-	-	141	154	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Potamothrix vejdovskyi	-	-	-	-	167	487	1576	4	64	64	1473	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tubifex tubifex	-	-	-	-	-	-	-	-	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peloscolex multisetosus longidentus	-	-	-	-	-	-	-	-	-	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcteonais lomondi	-	-	-	-	13	-	-	-	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peloscolex ferox	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Immature Tubificidae Without Capilliform Chaetae	-	-	-	-	1371	19028	13556	128	13813	31277	13800	12429	-	-	-	-	-	-	4	-	-	4	72	-	-	-	-
Immature Tubificidae With Capilliform Chaetae	-	-	-	-	83	910	404	-	1384	3011	1281	1333	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Branchiura sowerbyi	-	-	-	-	-	-	-	-	-	-	5087	513	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bothrioneurum vejdovskyanum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Limnodrilus claparedeianus	-	-	-	-	-	-	-	-	-	-	-	243	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peloscolex multisetosus	-	-	-	-	-	-	-	-	-	-	-	461	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nais sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	4	-	-	-	-	-
Dero sp.	-	-	-	-	-	64	77	2	-	589	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Specaria josinae	-	-	-	-	-	115	32	-	-	461	558	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uncinais uncinata	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Enchytraeidae	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hirudinea	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Helobdella stagnalis	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Turbellaria																											
Rhabdocoela	22	11	4	-	-	-	-	-	-	19	102	25	11	4	4	-	32	86	11	-	32	11	-	15	25	29	-
Bryozoa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	517	-	-	-	-	-	-	-	-	-	-
Coelenterata																											
Hydra sp.	14	-	-	-	-	-	-	-	-	-	19	-	79	-	25	-	-	976	-	4	-	-	-	3272	-	18	-

Table 2-422 (Continued)

	STATION LE1				LE2				LE3				LE4			LE5				LE9				LE10			
Taxa	HD 7/7	HD 9/1	HD 10/27	HD 12/20	P 7/13	P 9/1	P 10/24	P 12/20	P 7/13	P 9/1	P 10/24	P 12/20	HD 7/7	HD 9/1	HD 10/28	HD 7/7	HD 9/1	HD 10/27	HD 12/20	HD 7/7	HD 9/1	HD 10/27	HD 12/20	HD 7/7	HD 9/1	HD 10/27	HD 12/20
Nematoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	4	-	-	-	-	-
Mollusca																											
Sphaerium sp.	-	-	-	-	6	-	6	-	58	32	13	-	-	-	-	-	-	4		-	-	-	-	-	-	-	-
Pisidium sp.	-	-	-	-	-	13	51	1	26	6	77	13	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
Physa sp.	4	25	7	-	-	-	-	-	-	-	-	-	4	140	-	18	32	32	7	-	118	7	4	4	65	32	4
Stagnicola sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Stagnicola emarginata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-
Viviparus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	18	-	-
Campeloma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Valvata sp.	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-
Valvata sincera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Amnicola sp.	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	25	4	11	-	65	-	22	-
Somatogyrus sp.	-	4	-	-	-	-	-	-	-	-	6	-	-	11	-	-	-	-	-	-	-	-	-	-	11	-	-
Pleurocera acuta	4	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	4	-	-	-	6	-	-	-	-	-	-
Planorbula sp.	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acari																											
Hydrachnellae	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-
Decapoda																											
Orconectes sp.	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphipoda																											
Gammarus sp.	319	348	323	-	6	-	6	-	45	-	64	-	111	700	413	90	660	237	-	531	1435	312	-	126	524	154	-
Hyalella sp.	-	-	-	-	-	-	-	-	-	-	-	-	22	25	36	86	197	699	-	4	4	4	-	-	18	47	-
Gammarus fasciatus	-	-	-	11	-	-	-	6	-	-	-	-	-	-	-	-	-	-	327	-	-	-	32	-	-	-	16
Hyalella azteca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	161	-	-	-	-	-	-	-	15
Isopoda																											
Asellus sp.	29	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	4	-	-	-	4	-	4	-
Ephemeroptera																											
Stenonema sp.	4	4	65	11	-	-	-	-	-	-	-	-	4	68	251	57	29	284	57	22	11	29	-	47	15	104	-
Caenis sp.	-	-	-	4	-	-	-	-	-	-	-	-	-	-	11	90	4	21	492	-	-	-	-	-	-	4	-
Trichoptera																											
Cheumatopsyche sp.	-	-	-	4	-	-	-	-	-	-	-	-	7	15	50	104	728	1529	570	-	11	29	22	-	-	4	-
Hydropsyche sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Hydroptila sp.	-	-	-	-	-	-	-	-	6	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceraclea sp.	-	-	-	-	-	-	-	-	-	-	-	-	4	4	-	15	-	-	-	-	-	-	-	-	-	-	-
Triaenodes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-
Polycentropus sp.	-	-	-	-	-	-	-	-	-	-	6	-	-	-	4	-	-	58	7	-	-	-	4	-	-	-	-
Polycentropus cinereus	7	90	79	11	-	-	-	-	-	-	-	-	4	47	64	4	43	11	4	43	29	18	4	4	54	33	25
Neureclipsis crepuscularis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	29	-	-	-	-

Table 2-422 (Continued)

	STATION																										
	LE1				LE2				LE3				LE4			LE5				LE9				LE10			
Taxa	MD 7/7	MD 9/1	MD 10/27	MD 12/20	P 7/13	P 9/1	P 10/24	P 12/20	P 7/13	P 9/1	P 10/24	P 12/20	MD 7/7	MD 9/1	MD 10/28	MD 7/7	MD 9/1	MD 10/27	MD 12/20	MD 7/7	MD 9/1	MD 10/27	MD 12/20	MD 7/7	MD 9/1	MD 10/27	MD 12/20
Coleoptera																											
Stenelmis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Plecoptera																											
Allocapnia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-
Diptera																											
Empididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	11	-	-	-	-
Cryptochironomus cf. *digitatus*	-	-	-	-	13	6	51	2	6	6	6	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Chironomus sp.	14	-	-	-	199	6	19	-	1057	90	634	455	11	-	-	18	11	-	-	29	-	-	14	-	-	-	4
Procladius cf. *adumbratus*	7	-	-	7	929	276	6	-	1281	180	462	352	-	-	-	-	-	-	-	7	11	-	7	-	-	-	-
Coelotanypus concinnus	-	-	-	-	-	13	6	-	-	32	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtendipes sp.	4	-	4	-	-	-	-	-	-	-	-	-	25	-	165	126	-	-	-	-	-	36	-	-	-	43	25
Rheotanytarsus exiguus	-	11	-	18	6	-	-	2	-	-	-	-	25	147	-	32	337	366	287	4	7	-	312	-	-	7	15
Thienemannimyia ser. sp.	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	36	29	14	7	-	-	-	4	-	-	-
Cryptochironomus sp.	4	-	-	-	-	-	-	-	-	-	-	-	72	-	-	25	-	-	-	14	-	-	-	-	-	-	-
Psectrocladius sp.	4	11	-	-	-	-	-	-	-	-	-	-	36	4	-	179	11	-	-	-	-	-	-	-	-	-	-
Tanytarsus sp.	-	-	-	-	6	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus sp. 3	-	11	-	-	6	13	-	-	-	-	-	-	-	-	-	4	-	-	-	-	4	-	-	-	7	-	-
Tanypodinae sp.	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (Tripodura) sp.	-	-	-	-	6	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Micropsectra cf. *polita*	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicrotendipes neomodestus	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	18	-	-	-	-
Dicrotendipes sp.	-	4	-	-	-	-	-	-	-	-	-	-	4	-	-	201	11	-	-	-	4	-	-	-	-	-	-
Micropsectra sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Nanocladius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Trichocladius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	4	-	-	-	-	-	-	-
Microtendipes cf. *pedellus*	-	4	-	-	-	-	-	-	-	-	-	-	-	4	-	-	18	-	4	-	50	-	-	-	32	-	7
Cricotopus sp.	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomini sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Phaenopsectra (Tribelos) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rheotanytarsus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-
Parametriocnemus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-
Parachironomus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-
Chironomid Pupae	-	-	-	-	-	6	-	-	-	-	-	-	25	4	-	32	29	-	-	-	-	-	-	-	4	-	-
Total No. Taxa	15	11	7	10	25	21	15	10	20	26	21	18	17	15	10	22	19	17	18	13	19	12	15	10	12	15	10
Total No. Individuals	447	523	486	78	4230	24197	16917	156	29316	45414	24774	23205	448	1181	1023	1122	2710	4151	1971	698	1761	469	541	3548	787	509	113
Diversity Index	1.84	1.72	1.47	3.09	3.02	1.27	1.14	1.20	2.66	1.95	2.18	2.36	3.29	2.06	2.35	3.63	2.79	2.62	2.61	1.53	1.28	1.93	2.31	0.56	2.04	3.08	3.10

*One qualitative Ponar dredge.

Table 2-423 Average Number of Benthic Macroinvertebrates per Square Meter of Substrate in Lake Erie (LE) near the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April 28, 1978.

Taxa	STATION LE2 *P AS. 4/28/78	LE2 **P UAS. 4/28/78	LE3 P AS. 4/28/78	LE3 P UAS. 4/28/78
Oligochaeta				
Dero sp.	-	-	-	13
Paranais frici	-	-	13	26
Vejdovskyella intermedia	-	-	-	13
Aulodrilus americanus	26	13	141	64
Aulodrilus limnobius	58	32	51	77
Aulodrilus pluriseta	-	6	397	589
Bothrioneurium vejdovskyanum	13	19	-	-
Branchiura sowerbyi	-	-	2165	1576
Ilyodrilus templetoni	-	-	282	192
Limnodrilus cervix	-	-	38	-
Limnodrilus claparedeianus	45	13	-	-
Limnodrilus hoffmeisteri	231	173	372	372
Limnodrilus maumeensis	-	-	-	26
Limnodrilus udekemianus	-	-	230	308
Peloscolex freyi	58	77	-	-
Peloscolex multisetosus	13	-	474	513
Potamothrix moldaviensis	327	231	179	128
Potamothrix vejdovskyi	397	282	218	269
Tubifex tubifex	-	-	13	38
Immature Tubificidae Without Capilliform Chaetae	2230	1531	5907	6381
Immature Tubificidae With Capilliform Chaetae	45	13	974	935
Oligochaeta Egg Cocoons	-	-	333	519
Megadrile	-	13	-	-
Turbellaria				
Rhabdocoela	-	-	13	38
Amphipoda				
Gammarus sp.	-	-	-	6
Pelecypoda				
Sphaerium sp.	6	-	-	19
Pisidium sp.	32	19	45	96

Table 2-423 (Continued)

Taxa	STATION LE2 P AS. 4/28/78	LE2 P UAS. 4/28/78	LE3 P AS. 4/28/78	LE3 P UAS. 4/28/78
Gastropoda				
Viviparus sp.	-	-	-	6
Diptera				
Hemerodromia sp.	-	-	-	6
Cryptochironomus cf. *digitatus*	64	51	13	19
Cryptochironomus sp.	6	-	-	-
Procladius cf. *adumbratus*	6	6	442	711
Polypedilum (Tripodura) cf. *scalaenum*	-	25	-	-
Larsia curticalcar gr. sp.	-	6	-	-
Phaenopsectra (Tribelos) jucundus	-	6	-	-
Chironomus sp.	-	-	288	410
Coelotanypus concinnus	-	-	45	13
Total No. Taxa	16	18	21	27
Total No. Individuals	3557	2516	12633	13363
Diversity Index	2.02	2.13	2.79	2.90

*P AS. = Ponar assisted by SCUBA divers.

**P UAS. = Ponar unassisted.

Ephemeroptera, and Tricoptera occurred in greatest numbers.

2.889
The station with the highest total number of taxa throughout the study was LE5. The maximum total number of taxa, 22, occurred at LE5 in the May-July sampling period. Stations LE1 and LE10 usually had the lowest total number of taxa for any one sampling period. Station LE5 had the highest total number of individuals per square meter throughout the study followed by station LE4. The maximum density (No./m^2) of 4,151 was attained at LE5 in the September-October sampling period. The second highest density (3,548) occurred at LE10 in the May-July sampling period. This high density was due to the high abundance of one taxa, Hydra sp. Station LE1 had the lowest total number of individuals per square meter throughout the study period. The minimum density, 78, occurred at LE1 in the October-December sampling period.

2.890
A definite pattern in the distribution of Cheumatopsyche sp. was observed. Greatest numbers consistently occurred in 3.1 m (LE5) of water, lower numbers in 5.5 m (LE4), and extremely low numbers in 9.1 m (LE1, LE9, and LE10) of water. At the three stations located in 9.1 m of water, Cheumatopsyche sp. was collected only five times during the period of study, and the maximum number found was only 29 per square meter. This pattern of distribution held true not only for Cheumatopsyche sp. but for the entire Trichoptera population.

2.891
Overall, for open water sampling stations, benthos collected represented an assemblage indicative of good to excellent water quality and sediment with little organic enrichment.

Tributary Streams

2.892
Benthic macroinvertebrates collected in Conneaut Creek, Turkey Creek, and Raccoon Creek totalled 149 taxa, 179 taxa, and 103 taxa, respectively. The average number of benthic macroinvertebrates (species) per square meter of substrate for each sampling period is presented by creek in Tables 2-424, 425, 426, 427, and 428.

Conneaut Creek

2.893
In Conneaut Creek, two distinct habitat types were sampled. Stations CC1 and CC2 are characteristic of pool habitat while station CC3 is characteristic of riffle habitat. Additional habitat differences occur at stations CC1 and CC2. Station CC1 was located at the mouth

Table 2-424 Average Number of Benthic Macroinvertebrates per Square Meter of Substrate in Conneaut Creek (CC) at the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April 19, 1977 through April 12, 1978. (P = Ponar; S = Surber)

Taxa	STATION CC1 (P) 4/28	6/21	8/17	10/12	12/5	4/7	CC2 (P) 4/29	6/21	8/17	10/12	4/10	CC3 (S) 4/19	6/15	8/19	10/6	4/12
Oligochaeta																
Tubifex tubifex	25	269	-	-	-	-	-	-	-	-	167	-	-	-	-	-
Ilyodrilus templetoni	4632	525	6	-	205	-	-	6	13	-	6	-	-	-	-	-
Limnodrilus hoffmeisteri	16773	5856	653	1627	18707	3806	32	32	115	103	679	7	4	-	-	-
Limnodrilus cervix	3741	3011	70	-	8508	-	45	13	224	-	77	-	-	-	-	-
Limnodrilus maumeensis	-	3408	282	320	1730	1999	-	-	-	6	13	-	-	-	-	-
Limnodrilus udekemianus	602	218	83	103	308	-	19	6	38	64	115	-	-	-	-	-
Limnodrilus claparedeianus	4190	243	-	-	1614	192	19	-	58	-	218	43	-	-	-	-
Peloscolex multisetosus longidentus	641	448	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aulodrilus pluriseta	871	6394	231	231	10706	-	-	-	19	6	19	-	4	14	-	-
Potamothrix moldaviensis	564	128	-	-	-	-	6	-	-	6	13	-	-	-	-	-
Bothrioneurum vejdovskyanum	-	26	-	-	-	-	-	-	58	-	32	-	4	-	-	-
Aulodrilus limnobius	-	-	13	38	51	-	-	-	-	115	6	-	-	-	-	-
Aulodrilus pigueti	-	-	26	77	64	-	-	-	19	6	-	-	-	-	-	-
Branchiura sowerbyi	2704	525	77	103	2165	115	128	128	327	58	51	-	-	-	-	-
Peloscolex multisetosus	-	-	-	64	205	128	-	-	-	-	-	-	-	-	-	-
Peloscolex multisetosus multisetosus	-	-	64	-	-	-	-	-	6	-	-	-	-	-	-	-
Enchytraeidae	-	-	-	-	-	-	6	-	6	6	128	-	-	-	-	-
Dero sp.	-	13	-	-	282	-	-	-	-	-	-	-	-	-	-	-
Lumbriculidae	-	-	-	-	-	-	13	-	-	6	-	7	-	-	14	11
Immature Tubificidae Without Capilliform Chaetae	50574	24320	6010	43475	71998	3767	96	90	2543	1006	1608	4	-	4	22	7
Immature Tubificidae With Capilliform Chaetae	1704	3088	128	-	1845	-	-	6	96	58	109	-	-	-	-	-
Oligochaeta Egg Cocoons	-	-	-	-	-	51	-	-	-	-	6	-	-	-	-	-
Megadrile	231	-	-	-	-	-	-	-	-	-	-	7	22	-	-	-
Hirudinea																
Helobdella stagnalis	89	115	90	64	211	6	-	-	-	-	-	-	-	-	-	-
Nemertea	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-
Nematoda	-	-	-	-	-	-	-	-	19	19	-	-	-	4	-	7
Turbellaria																
Dalyellioida	-	-	26	1954	199	-	-	-	-	-	6	-	14	11	36	-
Mollusca																
Sphaerium sp.	6	6	-	45	154	-	-	-	-	6	-	100	197	22	61	-
Pisidium sp.	-	-	-	19	19	-	-	-	-	-	-	-	115	-	57	4
Stagnicola sp.	-	-	-	-	-	-	-	-	-	-	-	11	-	22	-	-
Ferrissia sp.	-	-	-	-	-	-	-	-	-	13	-	-	7	11	72	4
Acari																
Hydrachnellae	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Decapoda																
Astacidae	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-
Orconectes sp.	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-

Table 2-424 (Continued)

Taxa	CC1 4/28	CC1 6/21	CC1 P 8/17	CC1 10/12	CC1 12/5	CC1 4/7	CC2 4/29	CC2 6/21	CC2 P 8/17	CC2 10/12	CC2 4/10	CC3 4/19	CC3 6/15	CC3 S 8/19	CC3 10/6	CC3 4/12
Amphipoda																
Gammarus sp.	-	-	13	6	-	-	-	-	-	-	-	-	-	-	-	-
Cladocera																
Leptodora kindtii	-	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-
Plecoptera																
Neoperla sp.	-	-	-	-	-	-	-	-	-	-	-	36	29	-	50	-
Neophasganophora sp.	-	-	-	-	-	-	-	-	-	-	-	-	4	-	4	-
Neoperla clymene	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-
Acroneuria arida	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	4
Acroneuria sp.	-	-	-	-	-	-	-	-	-	-	-	22	7	-	-	-
Allocapnia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Acroneuria abnormis	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Perlesta placida	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Alloperla sp.	-	-	-	-	-	-	-	-	-	-	-	7	7	-	-	-
Ephemeroptera																
Stenonema sp.	-	-	-	-	-	-	-	-	-	13	-	72	273	104	445	32
Isonychia sp.	-	-	-	-	-	-	-	-	-	-	-	11	140	22	140	-
Baetis sp.	-	-	-	-	-	-	-	-	-	-	-	-	75	32	-	-
Baetis intercalaris	-	-	-	-	-	-	-	-	-	-	-	-	22	18	-	-
Baetis vagans	-	-	-	-	-	-	-	-	-	-	-	-	7	7	-	-
Baetis levitans	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-
Ephemerella sp.	-	-	-	-	-	-	-	-	-	-	-	104	409	50	72	-
Ephemera guttulata	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Potamanthus sp.	-	-	-	-	-	-	-	-	-	-	-	-	4	-	7	-
Ephron album	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Caenis sp.	-	-	-	-	-	-	-	-	-	-	-	-	664	22	4	4
Paraleptophlebia sp.	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-
Ephemera simulans	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-
Trichoptera																
Hydropsyche bifida	-	-	-	-	6	-	-	-	-	6	6	79	470	266	664	32
Macronemum zebratum	-	-	-	-	-	-	-	-	-	-	-	68	161	301	118	-
Hydropsyche sp.	-	-	-	-	-	-	-	-	-	-	-	75	93	65	402	11
Cheumatopsyche sp.	13	-	-	-	13	-	-	-	-	-	6	68	316	180	764	8
Hydropsyche betteni	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Hydropsyche simulans	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Helicopsyche borealis	-	-	-	-	-	-	-	-	-	-	-	4	11	7	14	-
Chimarra obscura	-	-	-	-	-	-	-	-	-	-	-	-	-	61	22	-
Chimarra aterrima	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	4
Chimarra sp.	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-	-
Trentonius distinctus	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Rhyacophila sp.	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-
Glossosoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Neureclipsis sp.	-	-	-	-	-	-	-	-	-	-	-	4	4	-	-	-
Hydroptila sp.	-	-	-	-	-	-	-	-	-	-	-	4	22	25	-	-

Table 2-424 (Continued)

Taxa	CC1 4/28	CC1 6/21	CC1 P 8/17	CC1 10/12	CC1 12/5	CC1 4/7	CC2 4/29	CC2 6/21	CC2 P 8/17	CC2 10/12	CC2 4/10	CC3 4/19	CC3 6/15	CC3 S 8/19	CC3 10/6	CC3 4/12
Coleoptera																
Psephenus sp.	-	-	-	-	-	-	-	-	-	-	-	330	255	111	194	7
Ectoparia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-
Stenelmis sp.	19	-	-	13	-	6	6	-	-	-	13	1267	3179	761	757	72
Optioservus sp.	13	-	6	-	13	-	-	-	-	-	-	32	380	61	79	-
Dubiraphia sp.	-	6	-	-	-	-	6	-	-	6	-	-	-	-	-	-
Diptera																
Simulium sp.	13	-	-	-	-	-	-	-	-	-	-	29	-	36	7	-
Simulium venustum	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Eriocera spinosa	-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-
Eriocera sp.	-	-	-	-	-	-	-	-	-	6	-	-	29	-	18	-
Limnophila sp.	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Tricyphona sp.	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-
Tipula sp.	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Antocha sp.	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-
Eriocera fultonensis	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-
Atherix variegata	-	-	-	-	-	-	-	-	-	-	-	-	284	68	61	-
Hemerodromia sp.	-	6	-	-	-	-	-	-	-	-	6	43	-	-	-	-
Chaoborus punctipennis	-	-	38	-	6	-	-	-	-	-	-	-	-	-	-	-
Chaoborus sp.	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
Johannsenomyia sp.	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Chrysops sp.	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-
Muscidae	-	-	-	-	-	-	6	6	-	-	6	-	-	4	-	-
Eukiefferiella sp.	-	-	-	-	-	-	-	-	-	-	-	4	136	-	7	18
Thienemannimyia sp.	-	-	-	-	13	-	-	-	-	-	-	7	68	4	18	4
Cricotopus sp.	19	-	-	-	-	6	26	-	-	-	-	50	47	22	11	-
Microtendipes sp.	-	-	-	-	-	-	-	-	-	6	-	4	262	-	4	4
Eukiefferiella longicalcar gr. sp.	-	-	-	-	-	-	-	-	-	-	-	39	-	118	46	-
Rheotanytarsus exigua	13	13	-	-	26	-	-	-	-	-	-	-	474	11	4	-
Procladius cf. *adumbratus*	-	58	538	948	1204	19	-	-	45	-	-	-	18	-	-	-
Ablabesmyia auriensis	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-
Polypedilum (Tripodura) sp. 1	-	-	-	-	-	-	-	38	19	-	-	-	208	32	-	-
Chironomid pupae	26	-	-	-	-	-	6	-	-	-	-	39	43	18	11	14
Micropsectra cf. *polita*	-	-	-	-	-	-	-	-	-	-	-	-	68	4	-	-
Chironomus sp.	51	-	19	-	6	-	705	545	359	-	13	4	-	-	-	-
Polypedilum (Tripodura) sp.	-	-	-	-	-	-	32	-	6	-	19	-	-	-	-	4
Cryptochironomus cf. *digitatus*	-	-	32	-	-	6	6	-	13	-	-	-	4	-	-	-
Rheotanytarsus sp.	13	-	6	-	-	-	-	-	-	-	-	11	4	-	-	-
Polypedilum (Tripodura) sp. 2	6	-	-	-	-	-	13	-	70	-	-	-	-	-	-	-
Larsia curticalcar gr. sp.	61	-	-	-	-	-	13	32	13	-	-	-	40	-	-	-
Phaenopsectra (Tribelos) jucundus	-	-	-	-	-	-	198	-	6	-	-	-	4	-	-	-
Tanytarsus sp.	-	-	-	-	-	-	-	-	6	-	-	-	4	-	-	4
Procladius cf. *culiciformis*	154	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zavrelimyia carnea gr. sp.	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus cf. *glabrescens*	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladotanytarsus sp. 1	6	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-

Table 2-424 (Continued)

Taxa	CC1						CC2					CC3				
			P						P					S		
	4/28	6/21	8/17	10/12	12/5	4/7	4/29	6/21	8/17	10/12	4/10	4/19	6/15	8/19	10/6	4/12
Diptera (cont'd)																
Tanytarsus sp. 3	13	-	-	-	-	-	6	-	-	-	-	4	32	-	-	-
Orthocladiinae sp.	13	-	-	-	-	6	-	-	-	-	-	219	4	-	-	25
Tanypodinae sp.	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stictochironomus sp.	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-
Cryptochironomus sp.	-	-	-	-	-	-	6	-	-	-	-	-	4	-	-	-
Polypedilum fallax gr. sp. 2	-	-	-	-	-	-	13	-	-	-	-	-	11	-	-	-
Tricholadius sp.	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-
Natarsia fastuosa	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-
Paratendipes albimanus	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-
Polypedilum (Tripodura) cf. *scalaenum*	-	-	-	-	-	-	58	-	-	-	-	-	-	-	-	-
Trissocladius nivoriunda	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Stempellinella cf. *minor*	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Cricotopus junus	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Parametriocnemus sp.	-	-	-	-	-	-	-	-	-	-	-	18	14	-	-	-
Microtendipes cf. *pedellus*	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Cladotanytarsus conversus	-	6	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Chironomini sp.	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Micropsectra sp.	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Cardiocladius sp.	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-
Nilothauma sp.	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Coelotanypus concinnus	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-
Corynoneura sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Nanocladius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Orthocladius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Stempellinella cf. *brevis*	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Hemiptera																
Rhagovelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-
Megaloptera																
Sialis sp.	-	-	-	-	-	-	-	-	-	-	-	4	11	25	-	-
Nigronia sp.	-	-	-	-	-	-	-	-	-	-	-	-	7	-	4	-
Corydalus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Odonata																
Coenagrionidae	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
Argia sp.	-	-	-	-	-	-	-	-	-	6	-	-	4	-	18	-
Lanthus sp.	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Lepidoptera																
Pyrausta sp.	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paraponyx sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Total No. Taxa	34	22	22	18	28	12	29	11	23	24	27	44	73	41	36	24
Total No. Individuals	87817	48682	8437	49099	120272	10107	1501	902	4078	1546	3340	2933	8839	2568	4247	346
Diversity Index	2.12	2.41	1.81	0.80	2.02	1.87	3.00	1.99	2.23	2.18	2.63	3.37	3.94	3.90	3.69	3.35

Table 2-425 Average Number of Benthic Macroinvertebrates per Square Meter of Substrate in Turkey Creek (TC), at the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April 19, 1977 through March 30, 1978.

Taxa	TC1						TC3						TC4					
	4/19/77	6/14/77	8/9/77	10/6/77	12/8/77	3/30/78	4/20/77	6/14/77	8/9/77	10/6/77	12/8/77	3/30/78	4/20/77	6/14/77	8/9/77	10/6/77	12/8/77	3/30/78
Oligochaeta																		
Bothrioneurum vejdovskyanum	29	39	36	58	-	236	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus hoffmeisteri	32	-	4	-	-	25	4	-	-	-	-	-	4	14	-	-	-	-
Limnodrilus claparedeianus	18	-	-	-	-	40	7	-	-	-	-	11	-	-	-	-	-	4
Ilyodrilus templetoni	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Aulodrilus limnobius	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Immature Tubificidae without Capilliform Chaetae	11	68	-	61	15	320	-	4	-	4	4	15	4	14	-	-	4	18
Immature Tubificidae with Capilliform Chaetae	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-
Enchytraeidae	4	-	-	-	-	4	-	-	-	-	-	4	-	-	-	-	7	7
Nais sp.	4	-	-	-	-	-	-	-	-	25	-	7	-	-	-	-	-	-
Nais communis	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megadrile	11	18	4	4	4	-	7	7	-	-	4	11	22	4	7	4	-	-
Hirudinea																		
Dina bucera	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Nematoda	14	4	4	-	11	14	57	-	-	-	11	-	-	-	-	7	-	4
Mollusca																		
Sphaerium sp.	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ferrissia sp.	-	-	-	-	-	7	-	4	-	-	4	7	14	4	-	4	-	-
Pisidium sp.	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	4
Physa sp.	-	-	-	-	-	-	-	-	-	-	-	-	7	15	-	4	-	-
Decapoda																		
Immature Decapoda	-	-	4	4	-	-	-	18	-	-	-	-	-	7	4	-	-	-
Cambarus sp.	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-
Orconectes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-
Amphipoda																		
Gammarus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Eucopepoda																		
Eucyclops prasinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Plecoptera																		
Acroneuria abnormis	-	255	-	-	-	-	-	180	-	-	-	-	-	25	-	-	-	-
Perlesta placida	-	248	-	-	-	-	-	237	-	-	-	-	-	172	-	-	-	-
Isoperla bilineata	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Isoperla minuta	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Nemoura sp.	68	7	-	-	-	-	25	25	-	-	-	-	65	50	-	-	-	4
Alloperla sp.	18	-	-	-	-	-	14	-	-	-	-	-	4	-	-	-	-	-
Allocapnia sp.	-	-	-	-	190	65	-	-	-	-	79	-	-	-	-	-	506	14
Taeniopteryx sp.	-	-	-	-	40	-	-	-	-	-	4	-	-	-	-	-	-	-

Table 2-425 (Continued)

Taxa	TC1 4/19/77	TC1 6/14/77	TC1 8/9/77	TC1 10/6/77	TC1 12/8/77	TC1 3/30/78	TC3 4/20/77	TC3 6/14/77	TC3 8/9/77	TC3 10/6/77	TC3 12/8/77	TC3 3/30/78	TC4 4/20/77	TC4 6/14/77	TC4 8/9/77	TC4 10/6/77	TC4 12/8/77	TC4 3/30/78
Ephemeroptera																		
Stenonema sp.	36	4	22	420	133	93	15	18	-	47	-	4	-	-	-	-	-	-
Stenonema gildersleevei	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenonema tripunctatum	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	4
Baetis sp.	736	97	7	4	4	4	255	11	-	7	14	7	29	606	11	40	-	-
Baetis levitans	-	18	-	-	-	-	-	32	-	-	-	-	-	205	4	4	-	-
Baetis intercalaris	-	-	-	-	-	-	-	-	-	-	-	-	-	54	-	11	-	-
Baetis phyllis	-	18	-	-	-	-	-	47	-	-	-	-	-	4	-	-	-	-
Baetis vagans	-	11	11	-	-	-	-	-	-	-	-	-	-	4	4	-	-	-
Baetis cingulatus	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-
Leptophlebia sp.	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	4	-
Centroptilum sp.	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterocloeon sp.	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemera sp.	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemera simulans	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paraleptophlebia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	79	7	-
Trichoptera																		
Hydropsyche sp.	-	4	4	14	-	4	29	-	18	11	-	7	11	65	154	11	11	18
Hydropsyche betteni	4	7	-	21	4	14	50	29	-	18	4	-	1076	233	68	29	18	25
Hydropsyche bifida	-	-	-	-	-	-	-	7	4	-	-	-	-	15	-	-	-	-
Cheumatopsyche sp.	14	40	144	355	43	25	136	32	29	122	11	7	190	104	68	126	57	18
Helicopsyche borealis	-	-	-	-	-	-	-	-	-	-	-	-	11	7	4	-	-	-
Hydropsyche simulans	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	11	-
Chimarra sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Trentonius sp.	-	4	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Trentonius distinctus	-	-	-	-	-	-	-	4	-	-	-	-	-	4	-	-	-	-
Dolophilus moestus	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacophila lobifera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Rhyacophila sp.	29	-	-	-	4	4	25	-	-	-	-	-	40	-	-	-	-	-
Glossosoma sp.	25	4	-	-	-	-	50	-	-	-	-	-	61	7	-	-	-	-
Neureclipsis sp.	40	-	-	-	-	-	126	-	-	-	-	-	4	-	-	-	-	-
Hydroptila sp.	4	-	-	-	-	-	36	11	-	-	-	-	-	255	-	-	-	-
Rhyacophila fuscula	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	4
Pycnopsyche sp.	-	-	11	-	-	-	-	7	4	-	-	22	-	7	-	-	-	-
Micrasema sp.	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neophlax sp.	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	25
Coleoptera																		
Psephenus sp.	22	14	4	162	18	187	-	-	-	-	-	-	61	244	97	7	-	-
Stenelmis sp.	86	82	104	75	7	32	868	420	65	115	32	43	222	445	574	93	11	4
Optioservus sp.	76	147	158	387	43	294	901	488	58	172	68	194	567	1572	1643	215	118	147
Ancyronyx sp.	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Narpus sp.	11	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	-
Cleptelmis sp.	-	-	-	-	-	-	43	-	-	-	-	-	-	-	-	-	-	-
Macronychus sp.	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-
Deronectes sp.	-	7	-	-	-	-	-	21	-	-	-	-	-	11	-	-	-	-
Donacia sp.	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-
Helophorus sp.	-	-	-	-	-	-	-	-	-	4	-	-	-	4	-	-	-	-

Table 2-425 (Continued)

Taxa	TC1						TC3						TC4					
	4/19/77	6/14/77	8/9/77	10/6/77	12/8/77	3/30/78	4/20/77	6/14/77	8/9/77	10/6/77	12/8/77	3/30/78	4/20/77	6/14/77	8/9/77	10/6/77	12/8/77	3/30/78
Diptera																		
Simulium sp.	825	-	-	18	-	7	825	-	-	4	7	18	1611	477	4	104	133	86
Eusimulium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Simulium venustum	-	-	-	-	-	-	-	-	-	-	-	-	635	90	-	14	-	-
Tipula sp.	7	-	7	-	-	-	4	-	-	-	-	-	21	18	4	-	-	-
Tipula abdominalis	-	4	-	-	-	-	-	-	-	-	-	-	4	7	-	-	-	4
Dicranota sp.	-	-	-	7	7	-	-	22	4	4	7	-	-	-	-	-	-	-
Eriocera cinerea	-	-	-	4	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Limnophila sp.	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Antocha sp.	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicranota bimaculata	-	7	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-
Limonia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Hexatoma sp.	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-
Pedicia sp.	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
Eriocera longicornis	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-
Pseudolimnophila sp.	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Immature Tipulidae	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-
Culicidae	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muscidae	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnophora sp.	-	-	-	-	-	-	-	11	-	-	-	-	-	7	-	-	-	-
Hemerodromia sp.	-	-	-	-	-	4	-	-	-	-	7	4	-	-	4	-	-	11
Hemerodromia rogatoris	32	-	-	-	-	-	83	4	-	-	-	-	43	-	-	-	-	-
Chrysops sp.	-	4	-	14	-	4	-	4	-	18	11	22	-	-	4	-	-	4
Johannsenomyia sp.	-	-	-	11	4	11	-	-	-	4	18	4	4	-	-	-	-	-
Larsia curticalcar gr. sp.	-	7	4	-	-	-	-	4	-	-	-	-	4	61	-	-	-	-
Chironomini sp.	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtendipes sp.	-	-	-	-	-	-	-	25	-	-	-	-	-	22	4	-	-	-
Polypedilum (Tripodura) sp. 2	4	36	-	4	-	-	4	-	-	-	-	-	-	4	-	-	-	-
Thienemannimyia sp.	7	15	-	11	18	4	15	-	-	4	-	-	22	40	-	4	-	11
Parametriocnemus sp.	104	585	-	7	14	7	341	32	-	7	14	25	40	334	-	7	25	57
Microtendipes cf. pedellus	-	-	-	-	4	-	-	-	-	4	-	-	4	-	-	-	-	-
Polypedilum fallax gr. sp. 2	11	133	-	-	-	-	11	50	-	11	-	-	65	287	-	18	-	-
Nanocladius sp.	-	-	-	-	-	7	-	-	-	4	-	15	-	-	-	-	-	-
Cricotopus sp.	-	29	-	-	-	7	205	-	-	-	-	4	298	57	-	11	-	11
Rheotanytarsus exigua	4	-	-	-	4	4	7	11	-	-	-	-	4	29	-	4	-	-
Paracladopelma sp.	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Diplocladius sp.	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	40	-
Rheotanytarsus sp.	-	-	-	-	-	-	-	4	-	-	-	-	-	4	-	4	-	-
Orthocladiinae sp.	269	4	-	-	4	4	269	4	-	-	-	7	83	-	-	4	4	-
Thienemanniella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-
Eukiefferiella sp.	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	4	-	-
Polypedilum (Tripodura) cf. scalaenum	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
Tanytarsus sp. 3	-	-	-	-	-	-	4	4	-	-	-	-	-	14	-	-	4	-
Micropsectra cf. polita	-	-	-	-	-	-	-	25	-	-	4	-	-	14	-	-	-	-
Metriocnemus sp.	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
Rheocricotopus sp.	-	-	-	-	-	-	-	4	-	-	-	-	-	7	-	-	-	-

Table 2-425 (Continued)

Taxa	TC1 4/19/77	TC1 6/14/77	TC1 8/9/77	TC1 10/6/77	TC1 12/8/77	TC1 3/30/78	TC3 4/20/77	TC3 6/14/77	TC3 8/9/77	TC3 10/6/77	TC3 12/8/77	TC3 3/30/78	TC4 4/20/77	TC4 6/14/77	TC4 8/9/77	TC4 10/6/77	TC4 12/8/77	TC4 3/30/78
Diptera (Cont'd.)																		
Rutarsia fastuosa	4	4	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (Tripodura) sp.	4	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
Cladotanytarsus comversus	-	7	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus sp.	-	-	-	-	-	-	4	-	-	-	-	-	-	7	-	-	-	-
Dianesa sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Diamesa nivoriunda	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Trissocladius nivoriunda	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corynoneura taris	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brillia cf. *flavifrons*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Brillia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Cardiocladius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Dicrotendipes sp.	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-
Procladius sp.	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (Tripodura) sp. 1	-	32	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Phaenopsectra (Tribelos) juncundus	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsini sp.	-	-	-	-	-	-	-	4	-	-	-	-	-	4	-	-	-	-
Micropsectra sp.	-	-	-	-	-	-	-	4	-	-	-	-	-	4	-	-	4	-
Cladotanytarsus sp. 1	-	4	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Chironomus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Chironomid pupae	50	194	-	-	-	-	201	72	4	11	-	-	-	133	-	7	-	-
Hemiptera																		
Rhagovelia sp.	-	-	-	-	-	-	-	11	-	-	-	-	-	7	-	-	-	-
Microvelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	-	-	-
Limnogonus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Odonata																		
Aeshna sp.	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-
Lepidoptera																		
Pyrausta sp.	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collembola																		
Proisotoma sp.	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-	-
Isotomidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Total No. Taxa	40	45	18	23	20	33	37	43	8	20	24	27	33	59	20	29	20	25
Total No. Individuals	2669	2207	539	1653	571	1457	4690	1927	186	600	333	472	5234	5846	2670	849	976	496
Diversity Index	3.32	3.85	2.83	2.94	3.10	3.41	3.64	3.67	2.27	3.13	3.74	3.50	3.17	4.02	1.81	1.60	2.50	3.54

Table 2-426 Average Number of Benthic Macroinvertebrates per Square Meter of Substrate in Turkey Creek Tributaries (TCT), at the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April 20, 1977 through March 30, 1978.

Taxa	TCT1			TCT2				Above TCT2		
	4/20/77	10/6/77	3/30/78	4/21/77	10/6/77	12/8/77	3/30/78	10/6/77	12/8/77	3/30/78
Oligochaeta										
Limnodrilus hoffmeisteri	6	-	-	-	-	818	7	-	-	4
Limnodrilus udekemianus	-	-	-	-	-	86	-	-	-	-
Peloscolex ferox	-	-	-	-	-	172	-	-	-	-
Peloscolex sp.	-	-	6	-	4	86	-	4	-	7
Immature Tubificidae without Capilliform Chaetae	-	103	17	4	32	1550	4	40	-	22
Immature Tubificidae with Capilliform Chaetae	-	-	-	-	7	129	-	4	-	-
Nais sp.	-	-	22	-	7	172	-	11	-	4
Enchytraeidae	-	-	-	-	4	22	4	11	-	11
Lumbriculidae	-	-	-	7	-	43	-	-	-	-
Rhyacodrilinae	-	-	-	-	4	-	-	-	-	-
Megadrile	27	22	22	-	29	108	4	25	22	7
Nematoda	-	-	-	7	-	-	-	-	-	-
Turbellaria	-	-	-	-	-	-	-	-	11	4
Mollusca										
Sphaerium sp.	7	-	-	-	-	22	-	-	-	-
Pisidium sp.	-	-	-	-	-	32	7	-	11	14
Decapoda										
Immature Decapoda	-	6	-	-	-	-	-	-	-	-
Orconectes sp.	16	-	-	-	-	-	-	-	-	-
Amphipoda										
Gammarus sp.	-	-	-	-	-	22	4	-	-	-
Hyalella azteca	-	-	6	-	-	-	-	-	-	-
Isopoda										
Asellus sp.	-	-	-	-	-	11	-	-	-	-
Acari										
Hydracarina	-	-	6	-	-	-	-	-	-	-
Plecoptera										
Taeniopteryx sp.	-	-	-	-	-	-	-	-	11	-
Nemoura sp.	16	-	-	-	-	-	-	-	-	4
Allocapnia sp.	-	-	22	-	-	11	-	-	-	-
Immature Plecoptera	-	-	-	-	-	-	-	-	32	-
Ephemeroptera										
Baetis sp.	-	-	-	7	7	-	-	32	54	-
Paraleptophlebia sp.	27	167	-	-	162	-	-	129	-	-

Table 2-426 (Continued)

Taxa	TCT1			TCT2				Above TCT2		
	4/20/77	10/6/77	3/30/78	4/21/77	10/6/77	12/8/77	3/30/78	10/6/77	12/8/77	3/30/78
Ephemeroptera (Cont'd.)										
Baetis levitans	-	-	-	-	-	-	-	4	-	-
Ephemera simulans	-	-	-	-	-	-	-	4	-	-
Ameletus lineatus	11	-	-	-	-	-	-	-	-	-
Siphlonurus sp.	6	-	-	-	-	-	-	-	-	-
Leptophlebia sp.	-	-	-	-	-	11	-	-	-	4
Trichoptera										
Hydropsyche sp.	6	-	-	-	7	-	4	122	75	32
Cheumatopsyche sp.	17	22	-	4	162	-	7	366	850	129
Hydropsyche betteni	6	-	-	4	39	-	14	237	463	108
Chimarra aterrima	-	-	-	-	-	-	-	65	86	-
Glossosoma sp.	6	-	-	4	-	-	-	-	-	-
Rhyacophila sp.	6	-	-	-	-	-	-	-	-	-
Pycnopsyche sp.	-	-	-	4	-	-	-	-	-	-
Hydropsyche simulans	-	-	-	-	-	11	-	-	-	-
Nyctiophylax sp.	-	-	-	-	-	-	-	-	11	-
Hydropsyche bifida	-	-	-	-	-	-	7	-	-	-
Neophylax sp.	-	-	-	-	-	-	-	-	-	18
Goera sp.	-	-	-	-	-	-	-	-	-	11
Coleoptera										
Psephenus sp.	6	-	-	-	7	-	-	4	-	-
Stenelmis sp.	6	-	-	11	4	-	14	201	592	43
Optioservus sp.	33	49	14	-	18	-	18	463	958	291
Anacaena sp.	-	-	-	-	-	-	-	4	-	-
Diptera										
Simulium sp.	44	7	-	61	40	-	7	22	43	83
Eusimulium sp.	-	-	-	-	4	-	-	-	-	-
Simulium venustrum	-	-	-	-	-	-	-	18	-	-
Eriocera cinerea	-	16	-	-	-	-	-	-	-	-
Dicranota sp.	-	-	-	-	-	-	-	18	11	-
Tipula sp.	16	6	-	4	-	43	-	-	-	-
Tipula abdominalis	11	-	-	7	-	54	-	-	11	-
Pseudolimnophila sp.	-	-	-	-	-	-	11	7	-	4
Erioptera sp.	6	-	-	-	-	11	-	-	-	-
Hemerodromia rogatoris	11	-	-	-	-	-	-	-	-	-
Chrysops sp.	-	11	-	-	11	-	-	22	11	-
Johannsenomyia sp.	-	-	11	-	-	22	-	-	11	-
Chaoborus sp.	-	-	-	-	-	11	-	-	-	-
Pilaria tenuipes	-	-	-	-	-	11	-	-	-	-
Hemerodromia sp.	-	-	-	-	-	-	4	-	32	11
Dolichopodidae	-	-	6	-	-	-	-	-	-	-
Rheotanytarsus sp.	-	-	-	4	4	-	-	4	-	-
Polypedilum fallax gr. sp. 2	-	-	-	7	11	-	-	-	-	-
Cricotopus sp.	6	17	-	29	7	-	-	-	-	-
Orthocladius sp.	-	-	-	11	-	-	-	-	-	-
Parametriocnemus sp.	6	17	11	4	7	22	15	18	129	43

Table 2-426 (Continued)

Taxa	TCT1			TCT2				Above TCT2		
	4/20/77	10/6/77	3/30/78	4/21/77	10/6/77	12/8/77	3/30/78	10/6/77	12/8/77	3/30/78
Diptera (Cont'd.)										
Natarsia fastuosa	33	-	6	4	-	-	4	-	11	-
Polypedilum (Tripodura) sp.	6	-	-	-	-	-	-	-	-	-
Eukiefferiella sp.	11	-	-	-	-	-	-	-	-	-
Thienemannimyia sp.	6	-	-	-	-	65	4	4	86	14
Polypedilum (Tripodura) sp. 2	-	6	-	-	-	-	-	-	-	-
Nanocladius sp.	-	-	33	-	4	-	-	-	-	68
Orthocladiinae sp.	-	6	6	-	-	-	-	-	-	4
Thienemanniella sp.	-	-	-	-	11	-	-	11	-	-
Larsia curticalcar gr. sp.	-	6	-	-	-	11	-	-	-	-
Rheotanytarsus exigua	-	-	-	-	-	11	-	-	22	11
Diplocladius sp.	-	-	-	-	-	43	4	-	-	-
Micropsectra sp.	-	-	-	-	-	22	-	-	11	-
Stictochironomus sp.	-	-	-	-	-	11	-	-	-	-
Cryptochironomus cf. *digitatus*	-	-	-	-	-	11	-	-	-	-
Trichocladius sp.	-	-	-	-	-	-	-	-	11	-
Conchapelopia sp.	-	-	-	-	-	-	-	-	54	-
Tanytarsus sp.	-	-	-	-	-	-	-	-	22	-
Cryptochironomus sp.	-	-	6	-	-	-	-	-	-	-
Microtendipes sp.	-	-	-	-	-	-	4	-	-	-
Micropsectra cf. *polita*	-	-	-	-	-	-	4	-	-	-
Chironomus sp.	-	-	-	-	-	-	-	-	-	4
Chironomid pupae	-	6	-	4	-	-	-	7	-	-
Hemiptera										
Rhagovelia sp.	-	-	-	-	4	-	-	-	-	-
Collembola										
Isotomurus sp.	-	-	6	-	-	-	-	-	-	-
Total No. Taxa	27	15	16	18	25	31	21	27	27	26
Total No. Individuals	358	467	200	187	596	3654	151	1857	3641	955
Diversity Index	4.39	2.99	3.73	3.50	3.37	3.02	4.16	3.38	3.13	3.49

Table 2-427 Average Number of Benthic Macroinvertebrates per Square Meter of Substrate in Mouth of Raccoon Creek (RC1), at the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April 26, 1978.

Taxa	RC1 Ponar 4/26/78
Oligochaeta	
Nais sp.	6
Aulodrilus limnobius	13
Limnodrilus claparedeianus	13
Limnodrilus hoffmeisteri	51
Limnodrilus udekemianus	26
Tubifex tubifex	13
Immature Tubificidae Without Capilliform Chaetae	135
Immature Tibificidae With Capilliform Chaetae	6
Enchytraeidae	58
Oligocheata Egg Cocoons	6
Isopoda	
Asellus sp.	6
Coleoptera	
Dubiraphia sp.	6
Diptera	
Erioptera sp.	6
Orthocladiinae sp.	128
Stictochironomus sp.	96
Paralauterborniella sp.	6
Cladotanytarsus sp. 1	13
Polypedilum (Tripodura) cf. *scalaenum*	96
Paratendipes albimanus	19
Parametriocnemus sp.	6
Microtendipes cf. *pedellus*	6
Larsia curticalcar gr. sp.	6
Rheocricotopus sp.	6
Chironomus sp.	6
Chironomid Pupae	6
Total No. Taxa	23
Total No. Individuals	739
Diversity Index	3.65

Table 2-428 Average Number of Benthic Macroinvertebrates per Square Meter of Substrate in Raccoon Creek (RC2), at the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April 21, 1977 through March 30, 1978.

Taxa	4/21/77	6/15/77	8/9/77	10/6/77	12/8/77	3/30/78
Oligochaeta						
Limnodrilus hoffmeisteri	-	4	-	-	-	4
Limnodrilus claparedeianus	-	-	-	-	-	7
Peloscolex multisetosus longidentus	-	4	-	-	-	-
Bothrioneurum vejdovskyanum	-	11	-	-	-	-
Immature Tubificidae Without Capilliform Chaetae	-	-	-	4	7	15
Enchytraeidae	-	-	-	-	-	4
Megadrile	4	4	-	-	4	-
Nemertea	-	4	15	-	4	-
Nematoda	-	22	-	29	7	144
Turbellaria	-	-	7	-	-	-
Mollusca						
Ferrissia sp.	7	4	11	11	7	-
Sphaerium sp.	-	-	-	4	4	-
Pisidium sp.	-	-	-	-	-	4
Plecoptera						
Nemoura sp.	11	4	-	-	-	-
Perlesta placida	-	82	-	-	-	-
Acroneuria abnormis	-	7	-	-	-	-
Taeniopteryx sp.	-	-	-	-	7	-
Allocapnia sp.	-	-	-	-	29	-
Alloperla sp.	-	-	-	-	4	-

Table 2-428 (Continued)

Taxa	4/21/77	6/15/77	8/9/77	10/6/77	12/8/77	3/30/78
Ephemeroptera						
Baetis sp.	32	474	7	4	-	4
Baetis vagans	61	377	-	-	-	7
Baetis phyllis	25	7	-	-	-	-
Baetis cingulatus	-	22	-	-	-	-
Baetis intercalaris	-	122	-	-	-	-
Baetis levitans	-	57	4	-	-	-
Isonychia sp.	-	143	-	4	-	-
Siphlonurus sp.	-	4	-	-	-	-
Paraleptophlebia sp.	-	4	-	-	-	-
Stenonema sp.	7	50	-	-	4	-
Heptagenia sp.	4	-	-	-	-	-
Stenonema femoratum	7	-	-	-	-	-
Trichoptera						
Hydropsyche sp.	7	4	11	11	-	-
Hydropsyche bifida	14	1367	7	18	18	4
Hydropsyche betteni	25	7	18	-	4	-
Cheumatopsyche sp.	25	1220	7	14	-	4
Rhyacophila sp.	4	-	-	4	-	-
Glossosoma sp.	7	57	4	-	-	-
Neureclipsis sp.	104	-	-	-	-	-
Chimarra aterrima	76	-	4	7	4	-
Chimarra sp.	-	18	-	-	-	-
Hydroptila hamata	-	4	-	-	-	-
Helicopsyche borealis	-	-	4	4	-	4
Psychomyia sp.	-	-	-	-	-	7
Coleoptera						
Psephenus sp.	32	25	29	50	11	7
Stenelmis sp.	187	201	205	115	126	79
Optioservus sp.	40	83	40	36	11	7
Macronychus sp.	4	-	-	-	-	-
Donacia sp.	-	-	7	-	-	-

Table 2-428 (Continued)

Taxa	4/21/77	6/15/77	8/9/77	10/6/77	12/8/77	3/30/78
Diptera						
Simulium sp.	2027	176	4	29	57	36
Simulium vittatum	-	-	-	-	-	7
Simulium venustum	362	75	-	-	-	-
Eriocera fultonensis	-	-	-	-	22	36
Eriocera longicornis	36	-	-	-	4	-
Antocha saxicola	4	-	-	-	7	-
Tipula abdominalis	-	4	-	-	-	-
Tipula sp.	-	11	-	-	-	-
Eriocera sp.	-	22	11	15	-	-
Dicranota sp.	-	7	-	-	18	-
Limnophila sp.	-	7	-	-	-	-
Atherix variegata	15	-	54	7	7	-
Hemerodromia sp.	25	-	-	-	7	11
Rheotanytarsus sp.	4	4	-	-	-	-
Polypedilum fallax gr. sp. 2	18	222	-	-	-	-
Rheotanytarsus exigua	47	140	-	-	-	-
Tanytarsus sp. 3	11	22	-	-	-	-
Cladotanytarsus sp. 1	4	4	-	-	-	-
Cladotanytarsus sp. 2	7	-	-	-	-	-
Cricotopus sp.	635	-	-	-	-	-
Parametriocnemus sp.	22	158	-	-	-	22
Orthocladiinae sp.	11	-	-	-	-	7
Corynoneura cf. *taris*	4	-	-	-	-	-
Polypedilum (Tripodura) sp. 1	-	25	-	-	-	-
Thienemannimyia sp.	-	11	-	-	-	4
Microtendipes sp.	-	7	-	-	-	-
Micropsectra cf. *polita*	-	15	-	-	-	-
Rheocricotopus sp.	-	22	-	-	-	-
Cladotanytarsus conversus	-	29	-	-	4	-
Stempellinella cf. *minor*	-	7	-	-	-	-
Eukiefferella sp.	-	4	-	-	-	4
Thienemanniella sp.	-	-	-	4	-	-
Stictochironomus sp.	-	-	4	-	-	-

Table 2-428 (Continued)

Taxa	4/21/77	6/15/77	8/9/77	10/6/77	12/8/77	3/30/78
Diptera (cont'd)						
Natarsia fastuosa	–	–	–	–	4	22
Natarsia sp.	–	–	–	–	4	–
Cricotopus cf. *bicinctus*	–	–	–	–	11	–
Nanocladius sp.	–	–	–	–	–	25
Orthocladius sp.	–	–	–	–	–	4
Metriocnemus sp.	–	–	–	–	–	4
Chironomid Pupae	140	86	–	4	–	–
Chironomid Adults	11	–	–	–	–	–
Unidentifiable Immature Diptera	–	–	–	–	–	4
Hemiptera						
Rhagovelia sp.	–	22	–	7	–	–
Amphipoda						
Gammarus sp.	–	–	–	–	–	4
Total No. Taxa	39	53	20	20	27	29
Total No. Individuals	4066	5472	453	381	396	491
Diversity Index	2.82	3.78	3.01	3.53	3.73	3.74

of Conneaut Creek in a deep pool (-9 m) while the pool area of CC2 was shallow (-1.5 m). The benthic community at stations CC1 and CC2 was comprised primarily of oligochaetes and chironomids. The riffle benthic community at station CC3 was comprisd primarily of aquatic insects such as Trichoptera, Ephemeroptera, Coleoptera, and Diptera.

2.894
Benthic community at station CC1 displayed eutrophic conditions while station CC2 exhibited mesotrophic conditions. The primary factor responsible for the condition at station CC1 is organic enrichment from the Conneaut sewage treatment plant, the main discharge of which is very near station CC1. Also sewage overflow enters Conneaut Creek upstream of station CC2 which is undoubtedly contributing to the mesotrophic condition noted at this station. From upstream to the mouth, stream water and sediment chemistry grades from excellent at station CC3 to moderately organically enriched at stations CC2 and CC1.

Turkey Creek

2.895
In Turkey Creek, the maximum total number of taxa collected was 59 at station TC4 on 14 June 1977. The maximum total number of individuals (5,846 per square meter) also occurred at station TC4 on 14 June 1977. The minimum total number of taxa (8) and minimum total number of individuals (186 per square meter) occurred at station TC3 on 9 August 1977.

2.896
The macroinvertebrate communities at main stream stations TC1, TC3, and TC4 were dominated by aquatic insects. The aquatic insects consisted of Plecoptera, Ephemeroptera, Trichoptera, Coleoptera, Diptera, Hemiptera, Odonata, Lepidoptera, and Collembola. Other macroinvertebrates found at stations TC1, TC3, and TC4 included Oligochaeta, Megadrile, Hirudinea, Nematoda, Mollusca, Decapoda, Amphipoda, and Eucopepoda. Coleoptera was the dominant order of aquatic insects collected over the entire study period.

2.897
In the Turkey Creek tributaries, the maximum total number of taxa (31) and maximum total number of individuals (3,654) occurred at station TCT2 on 8 December 1977. These high values were due to the large number of oligochaetes that were collected at station TCT2 on 8 December 1977. With the exception of TCT2 on 8 December 1977, the above TCT2 station had the highest total number of taxa and individuals over the entire study period. Station TCT1 had the minimum total number of taxa (15) on 6 October 1977. The minimum total number of individuals (151) occurred at station TCT2 on 30 March 1978.

2.898
Based upon the assemblage of benthic organisms collected, which included many members of intolerant Trichoptera, Ephemeroptera, and Plecoptera, it can be concluded that Turkey Creek has good to excellent water quality. Differences in benthic community composition and abundance between sampling stations were due primarily to physical differences between stations. In general, the main stream stations, which had larger riffles, faster flow, and coarser substrate than the other stations, provided a more diverse habitat for benthic organisms than the other sampling stations. Thus samples taken from the main stream resulted in a larger number of taxa and individuals being collected. Periodic depression of the benthic community was attributed to construction activities immediately above station TCT2. The effect, however, was not persistent throughout the period of study.

Raccoon Creek

2.899
In Raccoon Creek, station RC1 was located in a pool area at the mouth and was sampled on only one occasion in April with a ponar dredge. Station RC2 was located in a riffle area and was sampled with a Surber sampler on six occasions from April 1977 to March 1978. On 15 June 1977, station RC2 had the highest number of taxa (53) and individuals (5,472). Lowest total number of taxa (20) occurred on 9 August and 6 October 1977. Lowest number of individuals (381) occurred on 6 October 1977. The benthic community of station RC2 consisted of aquatic insects, Oligochaeta, Megadriles, Nemertea, Nematoda, Turbellaria, Mollusca, and Amphipoda. Aquatic insects, represented by Diptera, Coleoptera, Trichoptera, Ephemeroptera, Plecoptera, and Hemiptera, were the dominant group of benthic organisms collected. The Diptera population reached a maximum density of $3{,}383/m^2$ on 21 April 1977 and remained a major component of the benthic community throughout the study period.

2.900
Station RC1 produced a total of 23 taxa on 23 April 1978. Diptera comprised 54.1 percent of the benthic community, Oligochaeta 44.2 percent, Coleoptera 0.8 percent and Isopoda 0.8 percent. This population represents mesotrophic conditions which is normal for that type of location.

2.901
As with Turkey Creek the assemblage of benthic macroinvertebrates in Raccoon Creek is indicative of good to excellent water quality.

Ichthyoplankton

Lake Erie - Nearshore

2.902
The nearshore ichthyoplankton sampling program consisted of two major programs. Nearshore sled tows in approximately one meter of water were designed to provide an estimate of abundance and distribution of larvae along the Lake Erie shoreline. Nearshore larval seine collections were included in the program to qualitatively assess the utilization of shoreline waters less than one meter deep. The following text, Tables and Figures summarize ichthyoplankton collection results and affords the reader the opportunity to make generalizations about the species composition of the sampled area. For a detailed account of individual speces numbers date and station they were collected, tables in Appendix D have been included to provide tht information. Additional ichthyuoplankton studies will be conducted along a transient for which the proposed intake structure would be placed. Details of the study are included in Chapter Four under Entrainment.

Nearshore Sled

2.903
Nearshore ichthyoplankton sled tow collections were obtained with a 0.5 mete conical net (505 u mesh) between 1 June 1977, and 26 April 1978. Individual samples were collected by pulling the sled 30 to 40 meters parallel to the shoreline.

2.904
Fish eggs were collected in nearshore sled collections during June, July, and August 1977. A total of six taxa were represented in the collections. Unidentifiable and unidentified eggs accounted for 77 percent of the total number collected. Unidentified minnow and carp eggs accounted for nearly 23 percent of the total number of eggs collected. Unidentified minnow eggs were taken in June, July, and August 1977. Carp eggs were found between late June and mid-July 1977. Unidentified percid and freshwater drum eggs were also occasionally collected during the sampling period.

2.905
Total density of eggs ranged from 42/1,000 m^3 at Station LE11 to 10,668/1,000 m^3 (75.4 percent unidentifiable) at Station LE10. Carp and unidentified minnow eggs were most abundant at Stations LE9 (1,281/1,000 m^3) and LE 5 (895/1,000 m^3) respectively. Concentrations for carp and unidentified minnow eggs were greatest in June (755/1,000 m^3 and 568/1,000 m^3, respectively).

2.906
Ten taxa of juvenile fishes were collected during ichthyoplankton sampling. All 10 were collected during July 1977. Few juveniles were collected during other months. Unidentified minnows and the spottail shiner represented a majority of the juveniles collected (77 percent and 12 percent respectively). Both occurred most abundantly at Station LE11 (491/1,000 m^3 unidentified minnows and 42/1,000 m^3 spottail shiners). Unidentified minnows were most common in July while spottail shiners occurred primarily in August. Other taxa included in the collections were gizzard shad, rainbow smelt, striped shiner, longnose dace, channel catfish, smallmouth bass, unidentified darter, and freshwater drum. Juvenile fishes were collected between 1 June and 15 September 1977. A single juvenile unidentified minnow was collected at LE10 on 11 April 1978. This was the only specimen collected during nearshore ichthyoplankton sampling in 1978.

2.907
Larvae of 19 taxa, representing 10 families were collected between 1 June and 30 August 1977. No larvae were collected in 1978.

2.908
The majoity of the larvae collected (98 percent) during the study were Cyprinidae (minnows and carp). Of the remaining nine families, only Clupeidae (herrings) represented more than 0.5 percent of the total nearshore sled collection. Cyprinids comprised 98 percent of the total monthly catches in both June and July 1977. Carp and unidentified minnows were collected from all of the nearshore locations, while gizzard shad were collected at all stations except LE9 and rainbow smelt at all sites except LE4 and LE5. Unidentified minnows and carp were the two most abundant taxa in the total monthly catches for June, July, and August 1977.

2.909
Total density of larvae ranged from 7,653/1,000 m^3 at Station LE2 to 69,528/1,000 m^3 (96.6 percent unidentified minnows) at Station LE10. Carp and unidentified minnows were most abundant at Stations LE5 (11,413/1,000 m^3) and LE10 (67,149/1,000 m^3), respectively. Concentrations of both taxa were high in June and July. Rainbow smelt larvae appeared in significant numbers at Station LE2 (169/1,000 m^3) and were most common in July (51/1,000 m^3 for all stations). Gizzard shad larvae occurred most abundantly at Station LE5 (338/1,000 m^3) and were most common in July (275/1,000 m^3 for all stations). Log perch and trout perch larvae were also collected in highest numbers at Station LE5 (542/1,000 m^3 and 686/1,000 m^3, respectively) and occurred primarily in June.

2.910
Tables 2-429 and 2-430 summarize catch results by month and station, respectively.

Nearshore Seine (505u mesh)

2.911
Seine samples were collected from 24 June through 30 August 1977. Two seine hauls were collected at each nearshore station during the first three weeks of sampling, after which only one seine haul was collected from each nearshore station. Collections were made with a 2.95m X 1.2m seine immersed in approximately one meter of water and pulled shoreward.

Of the three months that sampling was conducted, egg collections were highest in July (94.8 percent or 5,043 of all 5,317 eggs collected) and lowest in August when none were collected. Numbers were greatest at Stations LE5 (4,013) and LE11 (434). Unidentified minnow eggs were the most abundant species (4,690) and unidentifiable eggs were second in total number (580). Carp, trout, perch, freshwater drum, and unidentified eggs were also found but in insignificant numbers.

2.912
Of the juveniles collected, only gizzard shad were found in significant numbers (316). All were caught in July at Stations LE10 (2) and LE11 (314).

2.913
Larvae were dominated by unidentified minnows which accounted for over 98 percent (72,514 individuals) of the total catch. Of the 13 other identified taxa only carp and gizzard shad were collected in meaningful numbers, 1,071 and 109, respectively. Gizzard shad were found in July only, carp in June and July only and unidentified minnow in each of the three months sampled, however, August totals were very low (9). Over 63 percent of unidentified minnow larvae were collected at Station LE14, although all stations sampled did yield significant numbers of the larvae. Carp larvae were found primarily at Station LE4 (520) and gizzard shad at Station LE2 (42) and LE5 (40). Table 2-431 summarizes catch results by month.

2.914
Except for the weeks of 27 June - 1 July and 4-8 July 1977, larvae of more taxa were present in the nearshore sled collections than in the seine collections. Overall, from 24 June to 30 August, 11 larval taxa (gizzard shad, rainbow smelt, carp, longnose dace, minnows, unidentified suckers, trout-perch, rock bass, unidentified sunfish, logperch, and freshwater drum) were present in both sled and seine

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Table 2-429 - Summary by Month of Density (No./1,000^3) of Ichthyoplankton Taken in Nearshore Sled Collections at all Stations in Lake Erie near the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, June through August 1977*

Month	June	July	August	TOTAL
Volume filtered (m^3)	251.66	370.41	222.31	844.38
Species				
Eggs				
Carp	755	205	0	315
Unidentified minnow	568	327	292	389
Unidentified percid	8	0	0	2
Freshwater drum	12	13	0	9
Unidentified	2011	32	18	618
Unidentifiable	5805	124	0	1785
TOTAL	9159	702	310	3119
Larvae				
Gizzard shad	12	275	0	124
Rainbow smelt	0	51	22	28
Carp	5869	4090	36	3553
Longnose dace	12	3	0	5
Unidentified minnow	26289	26689	63	19560
White sucker	12	0	0	4
Unidentified sucker	8	0	0	2
Channel catfish	0	0	4	1
Trout-perch	127	0	0	38
Rock bass	0	13	0	6
Largemouth bass	0	3	0	1
Unidentified sunfish	0	30	0	13
Unidentified darter	44	0	0	13
Yellow perch	40	0	4	13
Logperch	262	3	0	79
Unidentified percid	12	0	4	5
Freshwater drum	4	24	4	13
Unidentified sculpin	12	0	0	4
Unidentified	0	0	4	1
Unidentifiable	60	238	0	122
TOTAL	32762	31419	144	23585
Juveniles				
Gizzard shad	0	5	0	2
Rainbow smelt	0	3	9	4
Striped shiner	0	3	0	1
Spottail shiner	0	16	58	23
Longnose dace	0	16	0	7
Unidentified minnow	8	335	13	153
Channel catfish	0	3	9	4
Smallmouth bass	0	3	0	1
Unidentified darter	0	5	0	2
Freshwater drum	0	5	0	2
TOTAL	8	394	90	199

*Collection results from September 1977 to April 1978 are as follows:

September (Density (No/1,000 m^3))

	LE1	LE2	LE9	LE10	Total
Volumn Filtered (m^3)	11.53	11.18	13.94	13.29	49.94
Juvenile					
Rainbow smelt	434	0	72	75	140
Unidentified minnow	0	0	72	0	20
	434	0	144	75	160

April (Density No/1,000 m^3)

	LE1	LE2	LE4	LE5	LE9	LE10	LE11	Total
Volumn Filtered (m^3)	23.7	22.7	15	19.8	20.1	20.2	39.9	161.4
Juvenile								
Unidentified minnow	0	0	0	0	0	50	0	6

Table 2-430 Summary by Station of Density (No./1000 m^3) of Ichthyoplankton Taken in Near Shore Sled Collections in Lake Erie near the Proposed U.S. Steel Lakefront Plant Site, Conneaut, *Ohio*, June through August 1977.

	STATION														
	LE1			LE2			LE4			LE5			LE9		
Time	D	N	Total	D	N	Total	D	N	Total	D	N	Total	D	N	Total
Volume filtered (m^3)	23.07	77.57	100.64	31.77	74.72	106.49	25.33	71.38	96.71	37.88	71.73	109.61	20.02	63.48	83.50
Species															
Eggs															
Carp	87	877	696	0	0	0	79	0	21	185	56	100	3646	536	1281
Unidentified minnow	0	1263	974	0	0	0	0	0	0	1874	376	894	2498	269	802
Unidentified percid	0	26	20	0	0	0	0	0	0	0	0	0	0	0	0
Freshwater drum	0	64	50	0	13	9	0	14	10	0	0	0	0	0	0
Unidentified	2731	206	785	0	0	0	118	126	124	1795	3011	2591	100	898	707
Unidentifiable	8756	2088	3617	1605	94	545	79	0	21	4752	516	1980	7293	945	2467
TOTAL	11573	4525	6141	1605	107	554	276	140	176	8606	3959	5565	13536	2647	5257

	STATION											
	LE10			LE11			LE14			Day	Night	Overall
Time	D	N	Total	D	N	Total	D	N	Total	Total	Total	Total
Volume filtered (m^3)	16.37	65.18	81.55	62.75	55.38	118.13	52.96	94.82	147.78	270.12	574.26	844.38
Eggs												
Carp	2750	384	858	0	18	8	0	53	34	478	239	315
Unidentified Minnow	977	568	650	0	0	0	245	0	88	555	312	389
Unidentified percid	0	0	0	0	0	0	0	0	0	0	3	2
Freshwater drum	0	15	12	0	0	0	0	0	0	0	14	9
Unidentified	2566	736	1104	0	0	0	0	0	0	659	599	618
Unidentifiable	38241	460	8044	64	0	34	0	0	0	4483	515	1785
Total	44533	2163	10668	64	18	42	245	53	122	6175	1682	3119

Table 2-430 (Continued)

STATION

	LE1			LE2			LE4			LE5			LE9		
Time	D	N	Total	D	N	Total	D	N	Total	D	N	Total	D	N	Total
Volume Filtered (m^3)	23.07	77.54	100.64	31.77	74.72	106.49	25.33	71.38	96.71	37.88	71.73	109.61	20.02	63.48	83.50
Species															
Larvae															
Gizzard shad	0	39	29	0	40	28	0	126	93	132	446	338	0	0	0
Rainbow smelt	0	13	10	220	147	169	0	0	0	0	0	0	0	16	12
Carp	390	632	576	126	696	526	237	15242	11312	30966	1087	11413	5694	2583	3329
Longnose dace	0	0	0	0	0	0	0	42	31	0	14	9	0	0	0
Unidentified minnow	31469	14928	18720	2581	8686	6864	869	10913	8282	15021	40792	31886	4196	22558	18156
White sucker	0	0	0	0	13	9	0	14	10	0	0	0	0	0	0
Unidentified sucker	0	0	0	0	0	0	0	28	21	0	0	0	0	0	0
Channel catfish	0	0	0	0	0	0	0	0	0	0	14	9	0	0	0
Trout-perch	0	0	0	0	0	0	0	14	10	686	0	237	150	16	48
Rock bass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	0	13	10	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified sunfish	0	0	0	0	0	0	0	0	0	26	14	18	0	142	108
Unidentified darter	0	0	0	0	13	9	0	0	0	211	0	73	0	32	24
Yellow perch	43	0	10	0	13	9	0	0	0	0	14	9	100	0	24
Logperch	87	0	20	0	54	38	118	14	41	528	14	192	400	0	96
Unidentified percid	0	13	10	0	0	0	0	42	31	0	0	0	0	0	0
Freshwater drum	0	39	30	0	0	0	0	14	10	0	0	0	0	16	12
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0	0	100	16	36
Unidentified	0	13	10	0	0	0	0	0	0	0	0	0	0	0	0
Unidentifiable	43	258	208	0	0	0	0	28	21	396	112	210	50	63	60
Total	32033	15947	19634	2927	9663	7653	1224	26478	19864	47967	42507	44394	10689	25441	21904

	LE10			LE11			LE14			Day	Night	Overall
Time	D	N	Total	D	N	Total	D	N	Total	Total	Total	Total
Volume Filtered (m^3)	16.37	65.18	81.55	62.75	55.38	118.13	52.96	94.82	147.78	270.12	574.26	844.38
Larvae												
Gizzard shad	0	153	123	80	108	93	57	306	217	48	160	124
Rainbow smelt	0	15	12	0	36	17	0	11	7	26	30	28
Carp	244	1411	1177	16	2745	1296	57	126	102	4865	2936	3553
Longnose dace	0	0	0	0	0	0	0	0	0	0	7	5
Unidentified minnow	6292	82433	67149	4209	14319	8950	4872	13679	10522	7804	25089	19560
White sucker	0	15	12	0	0	0	0	0	0	0	5	4
Unidentified sucker	0	0	0	0	0	0	0	0	0	0	3	2
Channel catfish	0	0	0	0	0	0	0	0	0	0	2	1
Trout-perch	0	15	12	0	0	0	0	0	0	107	5	38
Rock bass	0	46	37	16	36	25	0	0	0	4	7	6
Largemouth bass	0	0	0	0	0	0	0	0	0	0	2	1
Unidentified sunfish	0	0	0	0	0	0	0	0	0	4	17	13
Unidentified darter	0	0	0	0	0	0	0	0	0	30	5	13
Yellow perch	61	77	74	0	0	0	0	0	0	15	12	13
Logperch	0	430	343	0	0	0	0	0	0	122	59	79
Unidentified percid	0	0	0	0	0	0	0	0	0	0	7	5
Freshwater drum	0	61	49	0	18	8	0	11	7	0	19	13
Unidentified sculpin	0	0	0	0	0	0	0	0	0	7	2	4
Unidentified	0	0	0	0	0	0	0	0	0	0	2	1
Unidentifiable	0	675	540	0	144	67	0	0	0	63	150	122
Total	6597	85333	69528	4321	174[illegible]	10457	4985	14132	10854	13094	28520	23585

Table 2-430 (Continued)

STATION

	LE1			LE2			LE4			LE5			LE9		
Time	D	N	Total	D	N	Total	D	N	Total	D	N	Total	D	N	Total
Volume filtered (m^3)	23.07	77.54	100.64	31.77	74.72	106.49	25.33	71.38	96.71	37.88	71.73	109.61	20.02	63.48	83.50
Species															
Juveniles															
Gizzard shad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainbow smelt	0	0	0	0	0	0	0	14	10	0	0	0	0	16	12
Striped shiner	0	0	0	0	13	9	0	0	0	0	0	0	0	0	0
Spottail shiner	0	13	10	0	40	28	0	42	31	0	0	0	0	16	12
Longnose dace	0	39	30	0	0	0	0	0	0	0	0	0	0	47	36
Unidentified minnow	0	13	10	0	13	9	0	154	114	0	418	274	0	189	144
Channel catfish	0	0	0	0	0	0	0	0	0	0	14	9	0	16	12
Smallmouth bass	0	13	10	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified darter	0	0	0	0	0	0	0	0	0	0	0	0	0	32	24
Freshwater drum	0	0	0	0	0	0	0	0	0	0	0	0	0	16	12
Total	0	77	60	0	67	47	0	210	155	0	432	283	0	331	251

	LE10			LE11			LE14			Day	Night	Overall
Time	D	N	Total	D	N	Total	D	N	Total	Total	Total	Total
Volume filtered (m^3)	16.37	65.18	81.55	62.75	55.38	118.10	52.96	94.82	147.78	270.12	574.26	844.38
Juveniles												
Gizzard shad	0	0	0	0	18	8	0	11	7	0	3	2
Rainbow smelt	0	0	0	0	18	8	0	0	0	0	5	4
Striped shiner	0	0	0	0	0	0	0	0	0	0	2	1
Spottail shiner	0	0	0	0	90	42	0	63	41	0	33	23
Longnose dace	0	0	0	0	0	0	0	0	0	0	10	7
Unidentified minnow	0	46	37	32	1011	491	0	158	102	7	221	153
Channel catfish	0	0	0	0	18	8	0	0	0	0	5	4
Smallmouth bass	0	0	0	0	0	0	0	0	0	0	2	1
Unidentified darter	0	0	0	0	0	0	0	0	0	0	3	2
Freshwater drum	0	0	0	0	0	0	0	11	7	0	3	2
Total	0	46	37	32	1156	559	0	243	157	7	289	199

Table 2-431 Summary by Month of Total Number of Ichthyoplankton Taken in 505μ Mesh Seine Collections during the Day (D) and Night (N) in Lake Erie near the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, June through August 1977.

Month	June			July			August	Total	Total	TOTAL
Time	D	N	Total	D	N	Total	N	Day	Night	
Species										
Eggs										
Carp	0	0	0	0	11	11	0	0	11	11
Unidentified minnow	46	82	128	4479	83	4562	0	4525	165	4690
Trout-perch	0	1	1	0	0	0	0	0	1	1
Freshwater drum	0	1	1	0	2	2	0	0	3	3
Unidentified	3	0	3	29	0	29	0	32	0	32
Unidentifiable	31	110	141	88	351	439	0	119	461	580
TOTAL	80	194	274	4596	447	5043	0	4676	641	5317
Larvae										
Gizzard shad	0	0	0	51	58	109	0	51	58	109
Rainbow smelt	0	0	0	0	1	1	1	0	2	2
Carp	30	241	271	73	727	800	0	103	968	1071
Longnose dace	0	0	0	0	0	0	2	0	2	2
Unidentified minnow	6247	1282	7529	49400	15576	64976	9	55647	16867	72514
White sucker	0	0	0	0	1	1	0	0	1	1
Unidentified sucker	0	0	0	0	3	3	0	0	3	3
Trout-perch	0	0	0	3	1	4	0	3	1	4
Rock bass	0	0	0	1	5	6	0	1	5	6
Unidentified sunfish	0	0	0	1	1	2	0	1	1	2
Unidentified crappie	0	0	0	1	0	1	0	1	0	1
Yellow perch	0	1	1	0	0	0	0	0	1	1
Logperch	2	0	2	0	2	2	0	2	2	4
Freshwater drum	0	0	0	1	4	5	0	1	4	5
Unidentifiable	0	34	34	0	30	30	0	0	64	64
TOTAL	6279	1558	7837	49531	16409	65940	12	55810	17979	73789
Juveniles										
Gizzard shad	0	0	0	314	2	316	0	314	2	316
Striped shiner	0	0	0	0	0	0	1	0	1	1
Spottail shiner	0	0	0	0	1	1	4	0	5	5
Longnose dace	0	0	0	0	6	6	8	0	14	14
Unidentified minnow	0	0	0	0	41	41	5	0	46	46
Channel catfish	0	0	0	0	0	0	3	0	3	3
Smallmouth bass	0	0	0	0	0	0	1	0	1	1
Unidentified sculpin	0	0	0	0	2	2	0	0	2	2
TOTAL	0	0	0	314	52	366	22	314	74	388

collections. Channel catfish, largemouth bass, and darter larvae were present only in sled collections, while white sucker, crappie, and yellow perch larvae were present only in seine collections.

Lake Erie - Offshore

2.915
Fish eggs were collected in one-half meter conical plankton nets (505 u mesh) in offshore waters between 23 May 1977 and 26 April 1978. Bottom and surface tows were conducted simultaneously parallel to the shore at all stations except LE2 and LE3 where tows followed a J-shaped curve because of the harbor configuration. Standard tow time was five minutes for all stations. Location of sampling stations are shown. Four taxa of fish eggs, unidentified minnow, freshwater drum, unidentified, and unidentifiable, were present in the collections. Freshwater drum eggs accounted for 87 percent of all eggs collected in offshore samples. Freshwater drum eggs were collected during June and July 1977, having been most abundant in June surface collections. Highest densities of freshwater drum eggs occurred at Stations LE5 (108/1,000 m^3), LE6 (100/1,000 m^3), LE8 (59/1,000 m^3), and LE7 (53/1,000 m^3). Unidentified minnow eggs were sparse occurring only during June and only at LE2 and LE8. Other fish eggs (unidentified or unidentifiable) were relatively widely distributed but were not numerous.

2.916
Juveniles representing 14 taxa were collected in offshore ichthyoplankton samples. Unidentified minnows accounted for 53 percent (46/1,000 m^3) of the catch while rainbow smelt totaled 34 percent (27/1,000 m^3), gizzard shad 10 percent (9/1,000 m^3), and spottail shiner six percent (5/1,000 m^3). Unidentified minnows occurred primarily at stations LE2 (188/1,000 m^3), and LE3 (119/1,000 m^3) almost entirely during July. Rainbow smelt were most common at Stations LE15 (75/1,000 m^3), LE1 (53/1,000 m^3), LE9 (25/1,000 m^3), and LE13 (47/1,000 m^3), and occurred most abundantly during August and September.

2.917
Larvae were dominated by unidentified minnows which represented 74 percent (447/1,000 m^3) of the total catch. Rainbow smelt were second in abundance totaling nearly 10 percent (59/1,000 m^3), gizzard shad third with seven percent (40/1,000 m^3), and carp fourth with four percent (27/1,000 m^3). Highest concentrations of unidentified minnows occurred during July (978/1,000 m^3), while rainbow smelt peaked in June (141/1,000 m^3). Gizzard shad and carp peaked in July, 42/1,000 m^3, and 65/1,000 m^3, respectively. Unidentified minnows were caught at all stations, however, greatest numbers were found at Stations LE2 (3,326/1,000 m^3), LE11

(974/1,000 m^3), and LE14 (806/1,000 m^3). Rainbow smelt were found in highest densities at LE4 (122/1,000 m^3), LE6 (111/1,000 m^3), LE7 (135/1,000 m^3), and LE9 (95/1,000 m^3). Gizzard shad were in greatest densities at LE2 (287/1,000 m^3), while carp were most numerous at LE4 (101/1,000 m^3). Tables 2-432 and 2-433 summarize catch results by month and sampling station.

2.918
In general, the Lake Erie ichthyoplankton sampling program indicated that nearshore shallow and protected areas contain greater concentrations of eggs, larvae, and juvenile fish than offshore locations. Table 2-434, and Figure 2-153 illustrate ichthyplankton densities as they correspond to relative lake depths. Although shallow areas were sampled by beach seines and sled tows, only data from the latter could be calibrated to give numbers comparable to offshore catch results. Consequently, Table 2-434, and Figure 2-153, do not include beach seine data. Also noted in offshore catch results were variances between surface and bottom densities. (See Table 2-433) Gizzard shad and rainbow smelt larvae tended to occur more so at bottom depths while carp and unidentified minnow larvae were slightly more abundant at surface depths.

Raccoon Creek

2.919
Ichthyoplankton collections were obtained from Raccoon Creek between 3 May 1977 and 27 April 1978. Sampling was conducted at RCI only. (See Figure 2-148)

2.920
All eggs were taken during June 1977 with the majority occurring in night collections. Of all the eggs collected from Raccoon Creek, 11 percent were unidentified and 89 percent were unidentifiable.

2.921
Juvenile fishes were present in collections obtained from late June through mid-August. Stonecat and Johnny darter juveniles were collected in addition to unidentified minnows and unidentified darters.

2.922
Larvae of six taxa representing five families were present in collections made between 17 May and 10 August 1977. After 10 August 1977, all samples were devoid of ichthyoplankton.

2.923
Two families, Percidae (perches) and Catostomidae (suckers) comprised, the majority of larvae collected. Catostomid larvae were

TABLE 2-432 Summary by Month of Density of Ichthyoplankton (No./1,000 m^3) Taken Offshore During the Day and Night in One-half Meter Net Collections at All Stations (Stations LE1-LE15) in Lake Erie near the Proposed U. S. Steel Lakefront Plant Site, Conneaut, OH, April through August 1977 ***

	April			May			June			July			August			Total	Total	
Depth*	S	B	Total	S	B	Total	S	B	Total	S	B	Total	S	B	Total	Surface	Bottom	Total
Volume Filtered (m^3)	1070.11	857.32	1927.43	1219.11	1219.87	2438.98	3264.73	1731.97	4996.70	4399.60	4340.82	8740.42	3330.76	3373.56	6704.32	13284.31	13523.54	26807.85
Species																		
Eggs																		
Unidentified minnow	0	0	0	0	0	0	2	**	1	0	0	0	0	0	0	**	**	**
Freshwater drum	0	0	0	0	0	0	219	34	120	44	17	30	0	0	0	68	15	41
Unidentified	0	0	0	0	1	**	0	1	1	0	0	0	11	6	8	3	2	2
Unidentifiable	0	0	0	0	0	0	4	5	5	**	0	**	4	11	7	2	4	3
Total	0	0	0	0	1	**	225	41	127	44	17	30	15	16	16	74	22	47
Larvae																		
Alewife	0	0	0	0	0	0	0	0	0	0	0	0	0	**	**	0	**	**
Gizzard shad	0	0	0	3	2	3	8	14	11	92	132	112	0	0	0	33	47	40
Rainbow smelt	0	0	0	6	11	9	42	229	144	10	58	34	28	52	40	21	96	59
Carp	0	0	0	0	0	0	25	16	20	90	40	65	**	0	**	36	17	27
Unidentified minnow	0	0	0	0	0	0	502	371	470	934	1023	978	36	12	24	461	434	447
White sucker	1	0	**	1	0	1	0	0	0	0	0	0	0	0	0	**	0	**
Unidentified sucker	0	0	0	0	0	0	0	0	0	0	0	0	0	**	**	0	**	**
Channel catfish	0	0	0	0	0	0	0	0	0	**	2	1	0	**	**	**	**	**
Stonecat	0	0	0	0	0	0	0	0	0	0	0	0	0	**	**	0	**	**
Trout-perch	0	0	0	0	0	0	3	10	7	0	6	3	0	0	0	**	5	3
Brook silverside	0	0	0	0	0	0	0	0	0	0	0	0	**	0	**	**	**	**
Rock bass	0	0	0	0	0	0	8	**	4	0	**	**	0	0	0	2	**	1
Unidentified sunfish	0	0	0	0	0	0	**	0	**	**	**	**	0	**	**	**	**	**
Smallmouth bass	0	0	0	0	0	0	0	**	**	0	0	0	0	0	0	0	**	**
Unidentified crappie	0	0	0	0	0	0	0	0	0	0	**	**	0	0	0	0	**	**
Greenside darter	0	0	0	0	0	0	0	**	**	0	0	0	0	0	0	0	**	**
Rainbow darter	0	0	0	0	0	0	**	**	**	0	0	0	**	0	**	**	**	**
Unidentified darter	0	0	0	0	0	0	7	5	6	2	2	2	1	0	**	3	2	2
Yellow perch	0	0	0	2	5	3	9	25	17	0	0	0	0	0	0	2	7	5
Logperch	0	0	0	0	2	1	12	40	27	15	32	24	0	**	**	8	22	15
Unidentified percid	0	0	0	0	1	**	0	0	0	0	0	0	0	0	0	0	**	**
Freshwater drum	0	0	0	0	0	0	1	5	3	4	7	5	**	**	**	2	4	3
Unidentified sculpin	0	0	0	0	0	0	5	5	5	0	0	0	0	0	0	1	1	1
Unidentifiable	0	0	0	1	0	**	0	2	1	**	1	1	0	0	0	**	1	**
Total	1	0	**	12	21	17	702	724	713	1150	1304	1227	67	66	67	571	637	604
Juveniles																		
Gizzard shad	0	0	0	0	0	0	0	0	0	15	38	26	**	**	**	5	12	9
Rainbow smelt	0	0	0	0	0	0	0	0	0	5	7	6	54	99	77	15	27	21
Spottail shiner	0	0	0	0	0	0	0	0	0	0	25	12	0	9	5	0	10	5
Unidentified minnow	0	0	0	0	0	0	0	0	0	67	187	126	41	**	21	32	60	46
White sucker	0	0	0	0	0	0	0	0	0	0	**	**	0	0	0	0	**	**
Channel catfish	0	0	0	0	0	0	0	0	0	0	1	**	0	**	**	0	**	**
Unidentified bullhead	0	0	0	0	0	0	0	0	0	0	**	**	0	0	0	0	**	**
Trout-perch	0	0	0	0	0	0	0	1	**	**	20	9	**	**	**	**	7	3
Unidentified sunfish	0	0	0	0	0	0	0	0	0	0	0	0	**	0	**	**	0	**
Unidentified darter	0	0	0	0	0	0	0	0	0	0	1	**	0	0	0	0	**	**
Yellow perch	0	0	0	0	0	0	0	0	0	0	**	**	0	0	0	0	**	**
Logperch	0	0	0	0	0	0	0	0	0	**	6	3	0	0	0	**	2	1
Freshwater drum	0	0	0	0	0	0	0	0	0	**	**	**	0	0	0	**	**	**
Unidentified sculpin	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	**	**
Total	0	0	0	0	0	0	0	1	2	88	286	166	96	109	101	53	120	87

TABLE 2-432 Cont'd.

*   S - Surface B - Bottom
** Density less than 1
*** Sampling results for September 1977, October 1977, November 1977, and April 1978, are as follows:

	September LE9 Only		
	S	B	Total
Volume of Water Sampled	106.58	110.12	216.70
Rainbow smelt (Juveniles)	19	173	97

	April LE2 Only		
	S	B	Total
Sand shiner (Juveniles)	107.9	111.3	219.2
		18	9

Table 2-433 Summary by Station of Density (No./1000 m^3) of Ichthyoplankton Taken Offshore in One-half Meter Net Collections During the Day and Night in Lake Erie near the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April through August 1977.

	STATION											
	LE1			LE2			LE3			LE6		
Depth	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total
Volume Filtered (m^3)	1054.27	1115.80	2170.04	1029.79	1092.18	2121.97	1025.09	1082.95	2108.04	1003.91	1044.67	2048.58
Species												
Eggs												
Unidentified minnow	0	0	0	0	1	*	0	0	0	0	0	0
Freshwater drum	5	31	18	13	4	8	80	18	48	39	1	20
Unidentified	0	0	0	0	7	4	7	1	4	10	0	5
Unidentifiable	0		3	3	2	2	0	5	2	0	0	0
Total	5	37	21	16	14	15	87	24	55	49	1	24
Larvae												
Alewife	0	0	0	0	0	0	0	1	*	0	0	0
Gizzard shad	0	1	*	289	268	287	28	30	29	13	58	36
Rainbow smelt	11	61	37	3	13	8	3	28	20	25	213	122
Carp	7	2	4	64	74	71	54	16	34	181	24	101
Unidentified minnow	108	26	66	2171	4291	3326	197	395	[illegible]	76	53	64
White sucker	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified sucker	0	0	0	0	0	0	0	1	*	0	0	0
Channel catfish	0	0	0	0	3	1	1	6	3	0	1	*
Stonecat	0	1	*	0	0	0	0	0	0	0	0	0
Trout-perch	0	0	0	0	20	10	1	2	1	5	2	3
Brook silverside	0	0	0	0	0	0	1	0	*	0	0	0
Rock bass	0	2	1	18	0	9	5	2	3	0	0	0
Unidentified sunfish	0	0	0	1	0	*	2	1	1	0	1	*
Smallmouth bass	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified crappie	0	0	0	0	0	0	0	0	0	0	0	0
Centrarchid	0	0	0	0	1	*	0	0	0	0	0	0
Greenside darter	0	0	0	0	0	0	0	0	0	0	0	0
Rainbow darter	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified darter	1	0	*	1	2	1	2	0	1	1	3	2
Yellow perch	0	0	0	16	19	18	9	52	31	1	1	1
Logperch	0	3	1	85	109	100	7	24	16	2	6	4
Unidentified percid	0	0	0	0	0	0	0	1	*	0	0	0
Freshwater drum	0	0	0	1	3	2	6	7	7	1	1	1
Unidentified sculpin	0	0	0	1	9	5	6	4	5	0	0	0
Unidentifiable	0	0	0	0	5	3	1	1	1	1	0	*
Total	127	95	111	2650	4818	3844	332	570	454	309	362	336
Juveniles												
Gizzard shad	2	0	1	19	64	43	11	41	26	2	[illegible]	4
Rainbow smelt	28	76	53	2	5	4	6	10	8	16	28	22
Spottail shiner	0	8	4	0	86	44	0	3	1	0	1	*
Unidentified minnow	25	9	17	54	310	188	14	218	119	20	78	50
White sucker	0	0	0	0	1	*	0	0	0	0	0	0
Channel catfish	0	0	0	0	1	*	0	6	3	0	0	0
Unidentified Bullhead	0	0	0	0	0	0	0	1	*	0	0	0
Trout-perch	0	0	0	0	50	26	1	18	10	0	0	0
Unidentified sunfish	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified darter	0	0	0	0	3	1	0	1	*	0	0	0
Yellow perch	0	0	0	0	2	1	0	1	*	0	0	0
Logperch	0	1	*	0	4	2	0	3	1	1	0	*
Freshwater drum	0	0	0	0	0	0	0	1	*	0	0	0
Unidentified sculpin	0	0	0	0	5	3	0	2	1	0	0	0
Total	55	94	75	75	532	312	31	304	171	39	114	77

* Density less than 1.

Table 2-433 (Continued)

	STATION											
	LE9			LE10			LE11			LE12		
Depth	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total
Volume Filtered (m^3)	1132.61	1204.40	2337.01	1082.50	1172.17	2254.67	534.77	544.06	1078.83	479.68	447.83	927.51
Species												
Eggs												
Unidentified minnow	0	0	0	0	0	0	0	0	0	0	0	0
Freshwater drum	41	15	27	76	10	41	0	2	1	15	2	9
Unidentified	2	0	1	0	0	0	7	11	9	0	2	1
Unidentifiable	0	0	0	0	4	2	2	0	1	4	0	2
Total	42	15	28	76	15	43	9	13	11	19	*	12
Larvae												
Alewife	0	0	0	0	0	0	0	0	0	0	0	0
Gizzard shad	3	9	6	9	4	7	30	83	57	2	22	12
Rainbow smelt	15	171	95	4	49	27	21	42	32	19	130	72
Carp	28	9	18	18	2	10	54	20	37	0	2	1
Unidentified minnow	112	53	82	321	23	166	1754	208	974	173	31	105
White sucker	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified sucker	0	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	0
Stonecat	0	0	0	0	0	0	0	0	0	0	0	0
Trout-perch	0	1	*	0	3	1	0	0	0	0	9	4
Brook silverside	0	0	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified sunfish	0	0	0	0	0	0	0	0	0	0	0	0
Smallmouth bass	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified crappie	0	0	0	0	0	0	0	2	1	0	0	0
Centrarchid	0	0	0	0	0	0	0	0	0	0	0	0
Greenside darter	0	0	0	0	0	0	0	0	0	0	0	0
Rainbow darter	1	0	*	0	0	0	2	0	1	0	0	0
Unidentified darter	2	4	3	4	1	2	0	0	0	0	0	0
Yellow perch	1	2	2	0	2	1	0	0	0	0	0	0
Logperch	0	2	1	2	0	1	0	18	9	0	4	2
Unidentified percid	0	0	0	0	0	0	0	0	0	0	0	0
Freshwater drum	2	14	8	1	2	1	2	4	3	0	2	1
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0	0
Unidentifiable	0	0	0	0	0	0	0	6	3	0	0	0
Total	163	267	217	359	85	217	1862	382	1116	194	201	197
Juveniles												
Gizzard shad	6	12	9	0	0	0	2	11	6	6	0	3
Rainbow smelt	17	19	18	18	57	38	11	29	20	10	29	19
Spottail shiner	0	6	3	0	0	0	0	0	0	0	16	8
Unidentified minnow	85	2	42	4	17	11	129	72	100	10	20	15
White sucker	0	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified bullhead	0	0	0	0	0	0	0	0	0	0	0	0
Trout-perch	0	2	1	0	7	4	0	0	0	0	2	1
Unidentified sunfish	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified darter	0	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0	0
Logperch	0	1	*	0	3	1	0	0	0	0	0	0
Freshwater drum	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0	0
Total	108	42	74	21	84	54	142	112	127	27	67	46

* Density less than 1.

Table 2-433 (Continued)

	STATION											
	LE5			LE6			LE7			LE8		
Depth	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total
Volume Filtered (m^3)	1243.86	1296.44	2540.30	1088.11	962.07	2050.18	1095.95	1031.50	2127.45	1017.76	1062.02	2079.78
Species												
Eggs												
Unidentified minnow	0	0	0	0	0	0	0	0	0	7	0	3
Freshwater drum	176	42	108	170	20	100	92	11	53	110	9	59
Unidentified	3	5	4	8	0	4	0	0	0	0	0	0
Unidentifiable	9	19	16	0	5	2	0	5	2	8	0	4
Total	188	66	126	178	25	106	92	16	55	125	9	66
Larvae												
Alewife	0	0	0	0	0	0	0	0	0	0	0	0
Gizzard shad	10	39	24	6	9	7	2	14	8	13	12	13
Rainbow smelt	19	11	15	69	159	111	38	238	133	16	88	52
Carp	40	54	47	10	4	7	12	3	8	7	7	7
Unidentified minnow	449	143	293	164	73	121	78	46	63	67	30	48
White sucker	2	0	1	0	0	0	0	0	0	0	0	0
Unidentified sucker	0	0	0	0	0	[illegible]	0	0	0	0	0	0
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	0
Stonecat	0	0	0	0	0	0	0	0	0	0	0	0
Trout-perch	1	9	5	0	14	6	2	2	2	1	0	*
Brook silverside	0	0	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified sunfish	0	0	0	0	0	0	0	0	0	0	0	0
Smallmouth bass	0	0	0	0	1	*	0	0	0	0	0	0
Unidentified crappie	0	0	0	0	0	0	0	0	0	0	0	0
Centrarchid	0	0	0	0	0	0	0	0	0	0	0	0
Greenside darter	0	0	0	0	1	*	0	0	0	0	0	0
Rainbow darter	0	0	0	0	0	0	0	1	*	0	0	0
Unidentified darter	6	2	4	8	1	5	5	4	5	2	3	2
Yellow perch	3	8	6	0	4	2	0	0	0	0	1	*
Logperch	1	51	26	0	37	18	0	4	2	0	13	7
Unidentified percid	0	0	0	0	0	0	0	0	0	0	0	0
Freshwater drum	1	2	1	1	2	1	1	1	1	2	7	4
Unidentified sculpin	3	5	4	0	0	0	4	0	2	0	0	0
Unidentifiable	1	0	*	1	1	1	0	0	0	0	2	1
Total	535	322	426	258	307	281	142	312	225	107	162	135
Juveniles												
Gizzard shad	2	0	1	4	8	6	2	1	1	5	6	5
Rainbow smelt	9	2	6	19	5	13	5	16	10	14	8	11
Spottail shiner	0	1	*	0	1	*	0	1	*	0	3	1
Unidentified minnow	11	8	9	6	1	3	14	0	8	29	3	15
White sucker	0	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified bullhead	0	0	0	0	0	0	0	0	0	0	0	0
Trout-perch	0	0	0	0	0	0	0	0	0	0	1	*
Unidentified sunfish	1	0	*	0	0	0	0	0	0	0	0	0
Unidentified darter	0	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0	0
Logperch	0	0	0	0	0	0	0	3	1	0	5	2
Freshwater drum	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0	0
Total	23	11	17	28	16	22	20	20	20	47	25	36

* Density less than 1

Table 2-433 (Continued)

	STATION											
	LE13			LE14			LE15					
Depth	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total	Total Surface	Total Bottom	Total
Volume Filtered (m^3)	486.11	477.20	963.31	586.31	533.14	1119.45	423.62	457.41	881.03	13284.31	13523.84	26808.15
Species												
Eggs												
Unidentified minnow	0	0	0	0	0	0	0	0	0	*	*	*
Freshwater drum	39	27	33	0	0	0	0	2	1	68	15	41
Unidentified	0	4	2	2	2	2	0	0	0	3	2	2
Unidentifiable	0	0	0	0	6	3	7	0	3	2	4	3
Total	39	31	35	2	8	4	7	2	5	74	21	47
Larvae												
Alewife	0	0	0	0	0	0	0	0	0	0	*	*
Gizzard shad	6	13	9	20	139	77	0	13	7	33	47	40
Rainbow smelt	33	86	59	7	36	21	19	131	77	21	96	59
Carp	2	0	1	5	0	3	2	0	1	36	17	27
Unidentified minnow	123	17	71	1411	141	806	222	66	141	461	434	447
White sucker	0	0	0	0	0	0	0	0	0	*	0	*
Unidentified sucker	0	0	0	0	0	0	0	0	0	0	*	*
Channel catfish	0	0	0	0	0	0	0	0	0	*	1	*
Stonecat	0	0	0	0	0	0	0	0	0	0	*	*
Trout-perch	0	4	3	0	0	0	0	0	0	1	5	3
Brook silverside	0	0	0	0	0	0	0	0	0	*	0	*
Rock bass	0	0	0	0	0	0	0	0	0	2	*	1
Unidentified sunfish	0	0	0	0	0	0	0	0	0	*	*	*
Smallmouth bass	0	0	0	0	0	0	0	0	0	0	*	*
Unidentified crappie	0	0	0	0	0	0	0	0	0	0	*	*
Centrarchid	0	0	0	0	0	0	0	0	0	0	*	*
Greenside darter	0	0	0	0	0	0	0	0	0	0	*	*
Rainbow darter	0	0	0	0	0	0	0	0	0	*	*	*
Unidentified darter	2	4	3	0	0	0	0	2	1	3	2	2
Yellow perch	0	0	0	0	0	0	0	0	0	2	7	5
Logperch	0	0	0	0	11	5	0	0	0	8	22	15
Unidentified percid	0	0	0	0	0	0	0	0	0	0	*	*
Freshwater drum	6	4	5	3	2	3	5	4	5	2	4	3
Unidentified sculpin	0	0	0	0	0	0	0	0	0	1	1	1
Unidentifiable	0	4	2	0	0	0	0	0	0	*	1	1
Total	173	132	153	1446	328	914	248	216	232	571	638	605
Juveniles												
Gizzard shad	10	0	5	3	13	8	2	0	1	5	12	9
Rainbow smelt	29	65	47	27	9	19	47	101	75	15	27	21
Spottail shiner	0	27	13	0	0	0	0	0	0	0	10	5
Unidentified minnow	123	6	65	22	79	49	2	39	22	33	60	46
White sucker	0	0	0	0	0	0	0	0	0	0	*	*
Channel catfish	0	0	0	0	0	0	0	0	0	0	*	*
Unidentified bullhead	0	0	0	0	0	0	0	0	0	0	*	*
Trout-perch	0	4	2	0	0	0	0	2	1	*	7	3
Unidentified sunfish	0	0	0	0	0	0	0	0	0	*	0	*
Unidentified darter	0	4	2	0	0	0	0	0	0	0	*	*
Yellow perch	0	0	0	0	0	0	0	0	0	0	*	*
Logperch	0	2	1	0	0	0	0	0	0	*	2	1
Freshwater drum	0	0	0	2	0	1	0	0	0	*	*	*
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	1	*
Total	163	109	136	55	101	77	52	142	99	53	120	87

* Density less than 1.

Table 2-434

Average Number of Ichthyoplankton Sampled (per 1,000 m^3) during Peak Summer Months at Various Depths (Ichtyoplankton Here Includes Eggs, Larvae, and Juveniles)

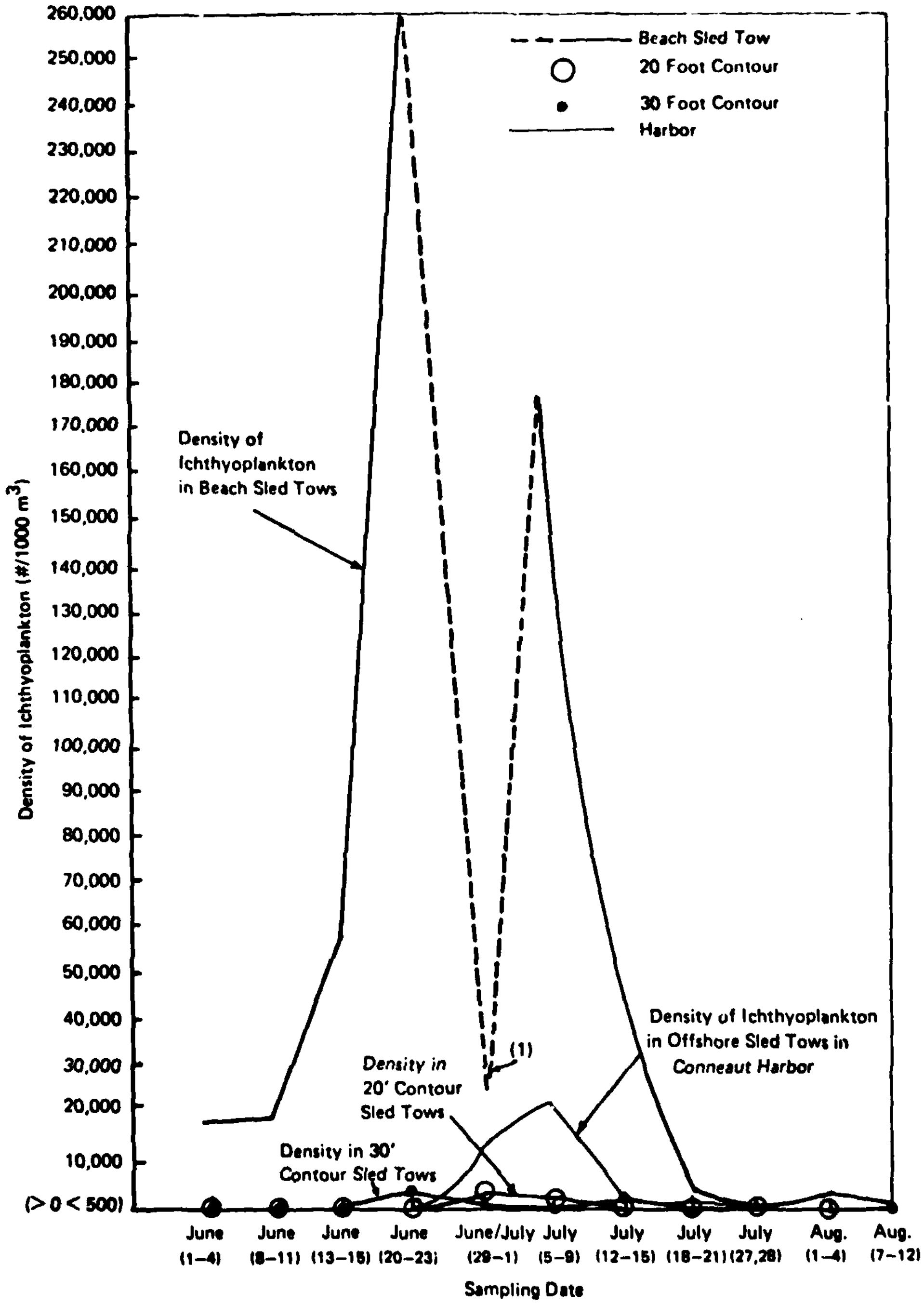
Sampling Dates	Average of Shallow, Beach Collections (Nearshore Sled Tows)		Average of Surface and Bottom 1/2 m Net Collections at 10 m Depth		Average of Surface and Bottom 1/2 m Net Collections at 17-20 m Depth		Average of Surface and Bottom 1/2 m Net Collections at 30 m Depth		Average of Surface and Bottom 1/2 m Net Collections at Conneaut Harbor	
	Average Density/ 1,000 m^3	No. of Samples for Average	Average Desity/ 1,000 m^3	No. of Samples for Average	Average Density/ 1,000 m^3	No. of Samples for Average	Average Density/ 1,000 m^3	No. of Samples for Average	Average Density/ 1,000 m^3	No. of Samples for Average
June 1-4	17,921	6	142.5	2	103	2	64.5	2	563	4
June 8-11	21,501	5	8[(3)]	2	11[(3)]	4	23[(3)]	6	49[(3)]	4
June 13-15	57,709	6	336.5	2	136	2	9	2	136	4
June 20-23	259,643	6	1,838[(3)]	2	413[(3)]	4	109[(3)]	6	218[(3)]	4
June 29/July 1	19,781	1[(1)]	1,787	2	3,359	4	2,874	2[(2)]	12,929	4
July 5-9	176,313	8	2,302	6	1,352	8	1,168	8	23,011	4
July 12-15	53,824	8	854	6	329	8	342	8	1,293	4
July 18-21	4,867	8	632	4[(2)]	470	8	1,028	8	2,143	4
July 27-28	52	8	48	6	154	8	105	8	1,051	4
Aug. 1-4	2,164	8	96	4	180	6[(2)]	494	6[(2)]	(2)	-
Aug. 9-10	342	8	134	6	36	6[(2)]	47	6[(2)]	54	4

(1) Inclement weather prevented sampling at all but one station.

(2) Includes samples not taken, not yet enumerated, or lost (see Appendix E).

(3) Day samples only, available.

Source: Modified from Aquatic Ecology Associates.



(1) Inclement weather prevented sampling at all but one station

Source: Arthur D. Little, Inc., based on Data From Aquatic Ecology Associates Reports

FIGURE 2-153 AVERAGE NUMBER OF ICHTHYOPLANKTON, PER 1000 m^3, AT VARIOUS DEPTHS IN LAKE ERIE AND CONNEAUT HARBOR (JUNE 1 TO AUGUST 12, 1977)

present in May (100 percent of the catch) and June 1977 (39 percent) collections. Percid larvae were only collected in June 1977, when they were the most abundant family (50 percent of the catch). Cyprinid (minnows and carp) larvae were abundant in July (100 percent of the catch) and August 1977 (67 percent).

2.924
The greatest number of taxa and the highest density of larvae (3,554/1,000 m^3), were observed in June 1977. The highest density of larval fish in an individual collection (9,663/1,000 m^3) occurred in the 9 June night collection. During June 1977, logperch and white sucker larvae together accounted for 89 percent of all larvae collected. Table 2-435 summarizes collection results.

2.925
Based on presence of larvae, in ichthyoplankton and benthos samples, as well as presence of ripe adults in adult fish collections, white sucker, logperch, and several species of darters and minnows undoubtedly spawn in areas of Raccoon Creek.

Turkey Creek

2.926
Ichthyoplankton collections were made at the mouth of Turkey Creek between 3 May 1977 and 26 April 1978. All sampling was conducted at Station TC1.

2.927
Eggs were collected at TC1 between 1 June and 19 July 1977. All eggs were either unidentified or unidentifiable.

2.928
Juvenile fishes were present in night collections obtained between 1 June and 28 July 1977, with additional specimens found in the 4 September 1977 collection. Ten taxa of juvenile fishes were present in the collections. Striped shiner, spottail shiner, white sucker, bluegill, and Johnny darter were present in addition to unidentified minnows, chubs, suckers, sunfish, and darters. Unidentified minnow and Johnny darter were the most abundant juveniles sampled and occurred in highest concentrations during July (969/1,000 m^3 and 1,140/1,000 m^3, respectively).

2.929
Larvae of nine taxa representing five families (minnows, suckers, catfishes, sunfishes, and perches) were collected between 1 June and 1 August 1977. Thus, fish eggs, larvae, and juveniles were only collected from Turkey Creek between 1 June and 4 September 1977.

Table 2-435 Summary by Month of Density (No./1000 m^3) of Ichthyoplankton Taken in Larval Sled Collections During the Day (D) and Night (N) at Station RC1 in the Mouth of Raccoon Creek at the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio May through August 1977.

Month	May	June			July	August	Total	Total	TOTAL
Time	D	D	N	Total	N	N	Day	Night	
Volume filtered (m)	12.41	27.67	26.64	54.31	15.41	23.07	40.08	65.12	105.20
Species									
Eggs									
Unidentified	0	0	38	18	0	0	0	15	10
Unidentifiable	0	36	263	147	0	0	25	107	76
TOTAL	0	36	300	166	0	0	25	123	85
Larvae									
Rainbow smelt	0	0	0	0	0	43	0	15	10
Unidentified minnow	0	0	188	92	1817	87	0	537	333
White sucker	81	217	2628	1399	0	0	175	1075	732
Unidentified sunfish	0	108	0	55	0	0	75	0	29
Unidentified darter	0	0	526	258	0	0	0	215	133
Logperch	0	145	3416	1749	0	0	100	1397	903
TOTAL	81	470	6757	3554	1817	130	349	3240	2139
Juveniles									
Unidentified minnow	0	0	0	0	584	433	0	292	181
Stonecat	0	0	0	0	0	43	0	15	10
Johnny darter	0	0	0	0	0	87	0	31	19
Unidentified darter	0	0	676	331	0	0	0	276	171
TOTAL	0	0	676	331	584	563	0	614	380

2.930
Cyprinidae (minnows) and centrarchidae (sunfishes) comprised the majority of larvae collected from Turkey Creek (2,553/1,000 m^3, and 1,283/1,000 m^3 respectively). Minnow larvae were collected in all three months but were most abundant in June and July, when they represented 72 percent and 36 percent of the respective monthly catches. All larvae collected in August 1977 were cyprinids. Sunfish larvae were collected in June and July 1977. The centrarchidae (sunfish) family was the most abundant family in July 1977, comprising 63 percent of the monthly catch.

2.931
The greatest number of taxa (8) was collected in June 1977, but the highest density of larvae (16,876/1,000 m^3) occurred in July 1977. The highest density of larval fish in an individual collection (35,101/1,000 m^3) occurred in the 21 June 1977 night collection. Table 2-436 summarizes collection results by month.

2.932
Based on presence of larvae in both ichthyoplankton and benthos samples as well as the presence of ripe adults in adult fish collections, white sucker, logperch, and several species of minnows, sunfish, and darters spawn in Turkey Creek.

Comparison of Turkey and Racoon Creeks

2.933
Larvae of nine taxa were collected in Turkey Creek, while six taxa were taken in Raccoon Creek. Minnows, white sucker, sunfish (Lepomis sp.), darters (Etheostoma sp.), and logperch larvae were collected in both creeks. Carp, unidentified sucker, stonecat, and crappie larvae were taken only in Turkey Creek. Rainbow smelt larvae were collected only in Raccoon Creek. Actual densities of larvae appeared higher in all months at the mouth of Raccoon Creek than at the mouth of Turkey Creek.

Conneaut Creek

2.934
Ichthyoplankton were collected in Conneaut Creek at Stations CC1 and CC2 from 29 April 1977 through 26 April 1978.

2.935
Eggs of three taxa were collected in June, July, and August 1977. Freshwater drum eggs were collected in all three months and were most abundant in June 1977 night samples, particularly at Station CC1. Unidentified and unidentifiable eggs were collected in June and

Table 2-436 Summary by Month of Density (No./1000 m^3) of Ichthyoplankton Taken in Larval Sled Collections During the Day (D) and Night (N) at Station TC1 in the Mouth of Turkey Creek at the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, April through August 1977.

Date	April	May	June			July	August	Total	Total	TOTAL
Time	D	D	D	N	Total	N	N	Day	Night	
Volume filtered (m^3)	5.98	58.30	26.82	25.15	51.97	17.54	23.65	91.10	66.34	157.44
Species										
Eggs										
Unidentified	0	0	75	0	38	0	0	22	0	13
Unidentifiable	0	0	0	40	19	57	0	0	30	13
TOTAL	0	0	75	40	57	57	0	22	30	25
Larvae										
Carp	0	0	0	0	0	798	0	0	211	89
Unidentified minnow	0	0	0	11928	5773	5359	338	0	6060	2553
White sucker	0	0	1044	1074	1058	0	0	307	407	349
Unidentified sucker	0	0	37	159	96	0	0	11	60	32
Stonecat	0	0	0	0	0	57	0	0	15	6
Unidentified sunfish	0	0	0	636	308	10604	0	0	3045	1283
Unidentified crappie	0	0	75	835	443	0	0	22	316	146
Centrarchid	0	0	37	0	19	0	0	11	0	6
Unidentified darter	0	0	0	119	58	0	0	0	45	19
Logperch	0	0	298	159	231	0	0	88	60	76
Unidentifiable	0	0	0	40	19	57	0	0	30	13
TOTAL	0	0	1491	14950	8005	16876	338	439	10250	4573
Juveniles										
Striped shiner	0	0	0	0	0	57	0	0	15	6
Spottail shiner	0	0	0	0	0	57	0	0	15	6
Unidentified minnow	0	0	0	80	38	969	0	0	286	121
White sucker	0	0	0	358	173	171	0	0	181	76
Unidentified sucker	0	0	0	0	0	114	0	0	30	13
Bluegill	0	0	0	0	0	57	0	0	15	6
Unidentified sunfish	0	0	0	0	0	57	0	0	15	6
Johnny darter	0	0	0	40	19	1140	0	0	316	133
Unidentified darter	0	0	0	159	77	0	0	0	60	25
TOTAL	0	0	0	636	308	2623	0	0	935	394

August 1977 primarily at Station CC2. Freshwater drum egg represented 92 percent (98/1,000 m^3) of all eggs collected while unidentified accounted for five percent (5/1,000 m^3).

2.936
Juvenile fishes representing 20 taxa were collected between June and September 1977. Of the total collection (97/1,000 m^3), unidentified minnows comprised 47 percent, trout perch 22 percent, rainbow smelt 12 percent, and channel catfish nine percent. The remaining 10 percent were comprised of 16 taxa. Unidentified minnows were common during July and August at both sampling sites representing 25 percent (33/1,000 m^3) at CC1 and 85 percent (57/1,000 m^3) at CC2. Rainbow smelt were collected only at Station CC1 during June (1/1,000 m^3), July (4/1,000 m^3), and August (34/1,000 m^3). Trout perch were also caught only at Station CC1 during June (6/1,000 m^3) and July (161/1,000 m^3).

2.937
Larvae of 17 taxa were collected in Conneaut Creek from 29 April through 30 August 1977. Larvae were not collected in 1978.

2.938
Larvae of 10 taxa representing seven families (herring, smelt, minnows, suckers, catfishes, sunfishes, and darters) were collected at both stations in Conneaut Creek. Carp, trout-perch, rock bass, freshwater drum, and sculpin larvae were collected only at Station CC1, while white sucker, stonecat, and unidentified bass larvae were collected only at Station CC2. Peak concentrations for both stations combined occurred in May (1,868/1,000 m^3). Station CC2 showed an overall higher concentration of larvae (515/1,000 m^3) than CC1 (397/1,000 m^3).

2.939
The majority of the larvae in Conneaut Creek (Stations CC1 and CC2 combined) consisted of percidae (perches and darters), Clupeidae (herrings), and Cyprinidae (minnows and carp). Percid larvae (primarily yellow perch and logperch) represented 37 percent of the total catch for Conneaut Creek between May and August 1977. Percidae were most abundant in May 1977 when they represented 61 percent of the monthly catch. Percid larvae represented 18 percent of the total catch at Station CC1 and 50 percent at Station CC2.

2.940
The only member of the family Clupeidae which was collected during larval fish sampling in Conneaut Creek was the gizzard shad. Gizzard shad larvae were most abundant during May 1977, when the species accounted for 38 percent of the combined monthly catch from CC1 and CC2. Gizzard shad larvae represented 23 percent and 33 percent of

the total catches at stations CC1 and CC2, respectively. Gizzard shad larvae were obtained from Conneaut Creek during May, June, and July 1977.

2.941
Cyprinidae were collected from Conneaut Creek during June, July, and August 1977. Minnow larvae represented a greater percentage of the total catch at Station CC1 than at Station CC2. (See Table 2-437)

Adult Fish

2.942
The Lake Erie fish community was sampled offshore by gill netting and inshore by seining near the proposed U.S. Steel Lakefront Plant site, Conneaut, Ohio, from April 1977 through April 1978. Monofilament gill nets, 38m in length with five square mesh sizes (19, 25, 38, 51, and 64mn) were set on the bottom overnight for approximately 12 to 14-hour periods. Seine nets were set at eight stations concurrently with laye gill nets. Sampling involved pulling a 15m seine (6.4 mn square mesh) in less than 1.5m of water for approximately 61m parallel to shore. Sampling stations are shown.

Offshore and Inshore Community Composition

2.943
A comparison of community composition by family, offshore and inshore, illustrates not only differences in composition between habitats, but also sampling selectivity between two gear types. Smallmouth bass for example tend to avoid gill nets. Thus relative abundance of fish species determined from collection results may be slightly misleading.

2.944
Considerable difference in community composition between the two habitats was evident. Cyprinids formed 66 percent of the seine catch but less than one percent of the gill net catch. Percidae, Percichthyidae, Sciaenidae, and Catostomidae comprised almost half of the offshore sample, while their total contribution to the inshore collections was less than two percent. Cluepids were abundant in collections made by either sampling method. Some of the differences between offshore and inshore community composition result from the selectivity of the sampling gear. Several cyprinids were likely to be abundant offshore, although the gill nets were not designed to effectively sample these species. Generally, however, diversity at nearshore stations was significantly higher than offshore stations.

2.945
A total of 29,599 fishes representing 50 species and 15 families were collected by both sampling methods from April 1977 through December

Table 2-437 Summary by Month of Density (No./1000 m^3) of Ichthyoplankton Taken in One-half Meter Net and Larval Sled Collections in Conneaut Creek (Stations CC1 and CC2 Combined) at the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, April through August 1977.

Month	April			May			June					July		
Time	Day			Day			Day		Night			Night		
Depth*	S	B	Total	S	B	Total	S	B	S	B	Total	S	B	Total
Volume filtered (m^3)	155.15	82.58	237.73	238.76	252.56	497.32	427.32	472.13	68.63	65.15	1033.23	408.23	437.14	845.37
Species														
Eggs														
Freshwater drum	0	0	0	0	0	0	19	68	437	614	106	441	213	323
Unidentified	0	0	0	0	0	0	0	13	0	0	6	0	0	0
Unidentifiable	0	0	0	0	0	0	5	13	0	0	8	0	0	0
TOTAL	0	0	0	0	0	0	23	93	437	614	120	441	213	323
Larvae														
Gizzard shad	0	0	0	8	1394	721	54	30	393	1381	149	7	25	17
Rainbow smelt	0	0	0	4	4	4	5	21	0	92	17	15	5	9
Carp	0	0	0	0	0	0	0	2	117	61	13	10	9	9
Unidentified minnow	0	0	0	0	12	6	2	42	1326	491	139	86	121	104
White sucker	0	0	0	4	0	2	0	0	0	0	0	0	0	0
Unidentified sucker	0	12	4	0	0	0	0	2	0	0	1	0	0	0
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	69	229	151
Stonecat	0	0	0	0	0	0	0	0	0	0	0	2	0	1
Trout-perch	0	0	0	0	4	2	0	0	73	0	5	0	25	13
Unidentified Temperate bass	0	0	0	0	4	2	0	0	0	0	0	0	0	0
Rock bass	0	0	0	0	0	0	0	0	44	31	5	0	2	1
Largemouth bass	0	0	0	0	0	0	0	0	0	0	0	5	2	4
Unidentified crappie	0	0	0	0	0	0	2	8	0	0	5	0	9	5
Unidentified darter	0	0	0	8	0	4	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	4	859	444	12	85	0	0	44	0	0	0
Logperch	0	0	0	21	1311	684	0	57	29	123	36	105	7	54
Freshwater drum	0	0	0	0	0	0	0	0	0	982	62	2	37	20
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0	0	14	7
Unidentifiable	0	0	0	0	0	0	2	0	0	0	1	0	0	0
TOTAL	0	12	4	50	3587	1868	77	248	1982	3162	476	301	485	396

*S = Surface, B = Bottom

Table 2-437 (Continued)

Month	August											
Time	Night			Total Day			Total Night			Total	Total	TOTAL
Depth*	S	B	Total	S	B	Total	S	B	Total	Surface	Bottom	
Volume filtered (m^3)	942.16	421.44	1363.60	821.23	807.27	1628.50	1419.02	923.73	2342.75	2240.25	1731.00	3971.25
Species												
Eggs												
Freshwater drum	0	17	5	10	40	25	148	152	149	97	99	98
Unidentified	8	14	10	0	7	4	6	6	6	4	7	5
Unidentifiable	0	14	4	2	7	5	0	6	3	1	7	4
TOTAL	8	45	20	12	55	33	154	165	158	102	113	107
Larvae												
Gizzard shad	0	0	0	30	453	240	21	109	56	25	270	131
Rainbow smelt	10	7	9	4	14	9	11	12	11	8	13	10
Carp	0	0	0	0	1	1	8	9	9	5	5	5
Unidentified minnow	21	88	42	1	28	15	103	132	114	66	84	74
White sucker	0	0	0	1	0	1	0	0	0	**	0	**
Unidentified sucker	0	0	0	0	2	1	0	0	0	0	1	1
Channel catfish	3	19	8	0	0	0	22	117	59	14	62	35
Stonecat	0	0	0	0	0	0	1	0	**	**	0	**
Trout-perch	0	0	0	0	1	1	4	12	7	2	7	4
Unidentified temperate bass	0	0	0	0	1	1	0	0	0	0	1	**
Rock bass	0	0	0	0	0	0	2	3	3	1	2	2
Largemouth bass	0	0	0	0	0	0	1	1	1	1	1	1
Unidentified crappie	0	0	0	1	5	3	0	4	2	**	5	2
Unidentified darter	1	0	1	2	0	1	1	0	**	1	0	1
Yellow perch	0	0	0	7	318	161	0	0	0	3	148	66
Logperch	0	0	0	6	443	223	32	12	24	22	213	106
Freshwater drum	0	0	0	0	0	0	1	87	35	**	46	20
Unidentified sculpin	0	0	0	0	0	0	0	6	3	0	3	2
Unidentifiable	0	0	0	1	0	1	0	0	0	**	0	**
TOTAL	35	114	59	55	1268	656	206	504	324	150	861	460

*S = Surface, B = Bottom
**Density less than 1/1000 m^3.

Table 2-437 (Continued)

Month	April			May			June					July		
Time	Day			Day			Day		Night			Night		
Depth*	S	B	Total	S	B	Total	S	B	S	B	Total	S	B	Total
Volume filtered (m³)	155.15	82.58	237.73	238.76	252.56	491.32	427.32	472.13	68.63	65.15	1033.23	408.23	437.14	845.37
Species														
Juveniles														
Gizzard shad	0	0	0	0	0	0	0	0	0	0	0	5	7	6
Rainbow smelt	0	0	0	0	0	0	0	0	0	15	1	2	2	2
Bigeye chub	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River chub	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified chub	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spottail shiner	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Longnose dace	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified minnow	0	0	0	0	0	0	0	0	0	0	0	145	78	110
White sucker	0	0	0	0	0	0	0	0	0	0	0	2	5	4
Channel catfish	0	0	0	0	0	0	0	0	0	0	0	59	16	37
Unidentified bullhead	0	0	0	0	0	0	0	0	0	0	0	2	0	1
Stonecat	0	0	0	0	0	0	0	0	0	0	0	0	11	6
Unidentified madtom	0	0	0	0	0	0	0	0	0	0	0	0	7	4
Trout-perch	0	0	0	0	0	0	0	0	0	61	4	0	178	92
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified sunfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified darter	0	0	0	0	0	0	0	0	0	0	0	0	9	5
Logperch	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Freshwater drum	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0	0	5	2
TOTAL	0	0	0	0	0	0	0	0	0	77	5	216	325	272

*S = Surface, B = Bottom

Table 2-437 (Continued)

Month	August											
Time	Night			Total Day			Total Night			Total	Total	TOTAL
Depth*	S	B	Total	S	B	Total	S	B	Total	Surface	Bottom	
Volume filtered (m^3)	942.16	421.44	1363.60	821.23	807.27	1628.50	1419.02	923.73	2342.75	2240.25	1731.00	3971.25
Species												
Juveniles												
Gizzard shad	0	0	0	0	0	0	1	3	2	1	2	1
Rainbow smelt	5	97	34	0	0	0	4	47	21	3	25	12
Bigeye chub	1	0	1	0	0	0	1	0	**	**	0	**
River chub	0	9	3	0	0	0	0	4	2	0	2	1
Unidentified chub	1	0	1	0	0	0	1	0	**	**	0	**
Spottail shiner	0	0	0	0	0	0	0	1	**	0	1	**
Longnose dace	0	2	1	0	0	0	0	1	**	0	1	**
Unidentified minnow	17	173	65	0	0	0	53	116	78	33	62	46
White sucker	0	0	0	0	0	0	1	2	1	**	1	1
Channel catfish	0	12	4	0	0	0	17	13	15	11	7	9
Unidentified bullhead	0	0	0	0	0	0	1	0	**	**	0	**
Stonecat	0	0	0	0	0	0	0	5	2	0	3	1
Unidentified madtom	0	0	0	0	0	0	0	3	1	0	2	1
Trout-perch	0	0	0	0	0	0	0	89	35	0	47	21
Bluegill	0	2	1	0	0	0	0	1	**	0	1	**
Unidentified sunfish	1	0	1	0	0	0	1	0	**	**	0	**
Unidentified darter	0	0	0	0	0	0	0	4	2	0	2	1
Logperch	0	0	0	0	0	0	0	1	**	0	1	**
Freshwater drum	0	0	0	0	0	0	0	1	**	0	1	**
Unidentified sculpin	0	0	0	0	0	0	0	2	1	0	1	1
TOTAL	25	297	109	0	0	0	79	294	164	50	157	97

*S = Surface, B = Bottom
**Density less than 1/1000 m^3.

1977. Inshore seine collections accounted for 68.9 percent (20,401) of the total catch and produced 41 species while offshore gill net collections contributed 31.1 percent (9,198) of the total with 29 species. (Table 2-438)

2.946
Collection data from April 1978 gill net and seine sampling were not included in the above Table 2-438. In brief summary, April 1978 collections resulted in an additional 3,059 individuals, 2,213 of which were emerald shiners, 422 spottail shiners, 149 freshwater drum, 63 yellow perch, 40 coho salmon, 33 rainbow smelt, and 137 represented by 24 taxa. Only a single species, mooneye, was caught that had not previously been collected. Emerald shiners were collected in seine nets only, with Stations LE9 and LE5 having produced the highest numbers. All except five spottail shiners were caught in seine nets and like emerald shiners appeared primarily at Stations LE9 and LE5. Freshwater drum, yellow perch, and coho salmon (except for one individual) were all caught in offshore gill nets. Freshwater drum were collected at all offshore stations sampled, and were most abundant at Stations LE6 and LE7. Yellow perch were also caught primarily at Stations LE6 and LE7. Coho salmon were found predominantly at Station LE2 (30 individuals).

2.947
The following discussions regarding adult fish includes data from the entire sampling program, April 1977 through April 1978 as outlined in the above paragraphs.

2.948
Gizzard shad was the most abundant species totalling 29.4 percent (9,606) of the combined catch. Emerald shiners were second accounting for 27.5 percent (8,976), while spottail shiners were third representing 19.6 percent (6,395) of the total catch. Except for 32 spottail shiners caught in gill nets, all spottail and emerald shiners were collected in seines. Yellow perch was fourth in overall abundance (8.96 percent) and except for one individual, all were caught in offshore gill nets (2,927). White bass and rainbow smelt were fifth (2.5 percent) and sixth (2.3 percent), respectively. White bass were caught primarily in offshore gill nets while rainbow smelt were caught largely in nearshore seines. Freshwater drum, striped shiner, longnose dace represented 2.15 percent, 0.98 percent, and 0.92 percent, respectively of the total catch. Chinook salmon caught almost entirely in nearshore sienes accounted for 0.84 percent of the total catch. Tables 2-439 and 2-440 list species caught at all stations for each month sampled by percent composition, total number, and mean catch per unit effort for gill net and seine collections.

Table 2-438 Total Number, Percent Composition, and Mean Catch per Unit Effort (C/f) of Fishes Collected by Gill Netting and Shore Seining at All Stations in Lake Erie near the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April through December 1977.

	GILL NET			SEINE			TOTAL	
Species	No.	%	C/f	No.	%	C/f	No.	%
Gizzard shad	4363	47.43	22.1	5243	25.70	22.4	9606	32.45
Yellow perch	2863	31.13	14.5	1	<0.01	<0.1	2864	9.58
White bass	629	6.84	3.2	172	0.84	0.7	801	2.71
Freshwater drum	539	5.86	2.7	11	0.05	<0.1	550	1.86
White sucker	173	1.88	0.9	12	0.06	0.1	185	0.63
Walleye	148	1.61	0.8	-	-	-	148	0.50
Smallmouth bass	72	0.78	0.4	-	-	-	72	0.24
Golden redhorse	60	0.65	0.3	-	-	-	60	0.20
Rock bass	57	0.62	0.3	2	0.01	<0.1	59	0.20
Stonecat	45	0.49	0.2	3	0.01	<0.1	48	0.16
Carp	40	0.43	0.2	2	0.01	<0.1	42	0.14
Shorthead redhorse	37	0.40	0.2	2	0.01	<0.1	39	0.13
Spottail shiner	32	0.35	0.2	5941	29.12	25.4	5973	20.18
Rainbow smelt	30	0.33	0.2	671	3.29	2.9	701	2.37
Trout-perch	26	0.28	0.1	229	1.12	1.0	255	0.86
Channel catfish	22	0.24	0.1	16	0.08	0.1	38	0.13
Longnose gar	13	0.14	0.1	1	<0.01	<0.1	14	0.05
Black redhorse	8	0.09	<0.1	-	-	-	8	0.03
Brown bullhead	7	0.08	<0.1	-	-	-	7	0.02
Chinook salmon	6	0.07	<0.1	273	1.34	1.2	279	0.94
Goldfish	6	0.07	<0.1	-	-	-	6	0.02
Quillback	5	0.05	<0.1	27	0.13	0.1	32	0.11
Rainbow trout	4	0.04	<0.1	13	0.06	0.1	17	0.06
Salmonidae	4	0.04	<0.1	-	-	-	4	0.01
Coho salmon	2	0.02	<0.1	97	0.48	0.4	99	0.33
Northern hog sucker	2	0.02	<0.1	2	0.01	<0.1	4	0.01
White crappie	2	0.02	<0.1	3	0.01	<0.1	5	0.02
Brown trout	1	0.01	<0.1	-	-	-	1	<0.01
Northern pike	1	0.01	<0.1	-	-	-	1	<0.01
Yellow bullhead	1	0.01	<0.1	-	-	-	1	<0.01
Emerald shiner	-	-	-	6763	33.15	28.9	6763	22.85
Striped shiner	-	-	-	319	1.56	1.4	319	1.08
Longnose dace	-	-	-	302	1.48	1.3	302	1.02
Logperch	-	-	-	72	0.35	0.3	72	0.24
Brook silverside	-	-	-	68	0.33	0.3	68	0.23
Alewife	-	-	-	38	0.19	0.2	38	0.13
Sand shiner	-	-	-	22	0.11	0.1	22	0.07
Mimic shiner	-	-	-	18	0.09	0.1	18	0.06
Common shiner	-	-	-	12	0.06	0.1	12	0.04
Mottled sculpin	-	-	-	10	0.05	<0.1	10	0.03
Bluegill	-	-	-	11	0.05	<0.1	11	0.04
Fathead minnow	-	-	-	8	0.04	<0.1	8	0.03
Stoneroller	-	-	-	7	0.03	<0.1	7	0.02
Lepomis sp.	-	-	-	4	0.02	<0.1	4	0.01
Largemouth bass	-	-	-	5	0.02	<0.1	5	0.02
Black crappie	-	-	-	2	0.01	<0.1	2	0.01
Golden shiner	-	-	-	2	0.01	<0.1	2	0.01
Rosyface shiner	-	-	-	2	0.01	<0.1	2	0.01
Bigeye chub	-	-	-	1	<0.01	<0.1	1	<0.01
Bluntnose minnow	-	-	-	1	<0.01	<0.1	1	<0.01
Creek chub	-	-	-	1	<0.01	<0.1	1	<0.01
Spotfin shiner	-	-	-	1	<0.01	<0.1	1	<0.01
Cyprinidae	-	-	-	7	0.03	<0.1	7	0.02
Pomoxis sp.	-	-	-	3	0.01	<0.1	3	0.01
Unidentifiable	-	-	-	1	<0.01	<0.1	1	<0.01
Total No. Species	29			41			50	
Total No. Individuals	9198			20401			29599	
Total C/f			46.7			87.2		

Table 2-439 Total Number, Percent Composition, and Mean Catch per Unit Effort (C/f) by Month of Fishes Collected by Gill Netting at All Stations in Lake Erie near the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April thorugh November 1977.

	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER		
Species	No.	%	C/f	No.	%	C/f	No.	%	C/f	No.	%	C/f	No.	%	C/f	No.	%	C/f
Gizzard shad	7	3.57	0.7	25	1.83	1.3	102	16.53	5.1	229	16.26	7.6	566	47.80	12.6	567	55.70	23.6
Yellow perch	126	64.29	12.6	1167	85.56	58.4	291	47.16	14.6	838	59.52	27.9	246	20.78	5.5	143	14.05	6.0
White bass	-	-	-	13	0.95	0.7	6	0.97	0.3	9	0.64	0.3	79	6.67	1.8	202	19.84	8.4
Freshwater drum	28	14.29	2.8	37	2.71	1.9	91	14.75	4.6	211	14.99	7.0	138	11.66	3.1	12	1.18	0.5
White sucker	8	4.08	0.8	14	1.03	0.7	27	4.38	1.4	28	1.99	0.9	25	2.11	0.6	26	2.55	1.1
Walleye	1	0.51	0.1	6	0.44	0.3	14	2.27	0.7	11	0.78	0.4	53	4.48	1.2	29	2.85	1.2
Smallmouth bass	1	0.51	0.1	3	0.22	0.2	16	2.59	0.8	23	1.63	0.8	21	1.77	0.5	5	0.49	0.2
Golden redhorse	1	0.51	0.1	6	0.44	0.3	5	0.81	0.3	10	0.71	0.3	9	0.76	0.2	7	0.69	0.3
Rock bass	2	1.02	0.2	6	0.44	0.3	19	3.08	1.0	7	0.50	0.2	13	1.10	0.3	5	0.49	0.2
Stonecat	4	2.04	0.4	7	0.51	0.4	12	1.94	0.6	9	0.64	0.3	9	0.76	0.2	4	0.39	0.2
Carp	-	-	-	10	0.73	0.5	9	1.46	0.5	14	0.99	0.5	4	0.34	0.1	-	-	-
Shorthead redhorse	1	0.51	0.1	4	0.29	0.2	5	0.81	0.3	6	0.43	0.2	9	0.76	0.2	11	1.08	0.5
Spottail shiner	2	1.02	0.2	23	1.69	1.1	1	0.16	0.1	-	-	-	1	0.08	<0.1	1	0.10	<0.1
Rainbow smelt	1	0.51	0.1	17	1.25	0.9	-	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	6	3.06	0.6	16	1.17	0.8	4	0.65	0.2	-	-	-	-	-	-	-	-	-
Channel catfish	3	1.53	0.3	3	0.22	0.2	3	0.49	0.2	6	0.43	0.2	3	0.25	0.1	1	0.10	<0.1
Longnose gar	1	0.51	0.1	-	-	-	10	1.62	0.5	1	0.07	<0.1	1	0.08	<0.1	-	-	-
Black redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	-	-	-	1	0.07	0.1	-	-	-	4	0.28	0.1	-	-	-	-	-	-
Chinook salmon	-	-	-	-	-	-	-	-	-	-	-	-	2	0.17	<0.1	3	0.29	0.1
Goldfish	-	-	-	1	0.07	0.1	1	0.16	0.1	1	0.07	<0.1	2	0.17	<0.1	-	-	-
Quillback	1	0.51	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rainbow trout	1	0.51	0.1	-	-	-	-	-	-	-	-	-	1	0.08	<0.1	1	0.10	<0.1
Salmonidae	-	-	-	4	0.29	0.2	-	-	-	-	-	-	-	-	-	-	-	-
Coho salmon	1	0.51	0.1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.10	<0.1
Northern hog sucker	-	-	-	-	-	-	-	-	-	-	-	-	1	0.08	<0.1	-	-	-
White crappie	-	-	-	-	-	-	-	-	-	1	0.07	<0.1	1	0.08	<0.1	-	-	-
Brown trout	-	-	-	-	-	-	1	0.16	0.1	-	-	-	-	-	-	-	-	-
Northern pike	-	-	-	1	0.07	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Yellow bullhead	1	0.51	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Species	19			20			18			17			20			16		
Total No. Individuals	196			1364			617			1408			1184			1018		
Total C/f			19.6			68.2			30.9			46.9			26.3			42.4

Table 2-439 (Continued)

Species	OCTOBER			NOVEMBER			TOTAL		
	No.	%	C/f	No.	%	C/f	No.	%	C/f
Gizzard shad	1854	83.21	77.3	1013	85.63	42.2	4363	47.43	22.1
Yellow perch	31	1.39	1.3	21	1.78	0.9	2863	31.13	14.5
White bass	225	10.10	9.4	95	8.03	4.0	629	6.84	3.2
Freshwater drum	19	0.85	0.8	3	0.25	0.1	539	5.86	2.7
White sucker	25	1.12	1.0	20	1.69	0.8	173	1.88	0.9
Walleye	30	1.35	1.3	4	0.34	0.2	148	1.61	0.8
Smallmouth bass	2	0.09	0.1	1	0.08	<0.1	72	0.78	0.4
Golden redhorse	14	0.63	0.6	8	0.68	0.3	60	0.65	0.3
Rock bass	4	0.18	0.2	1	0.08	<0.1	57	0.62	0.3
Stonecat	-	-	-	-	-	-	45	0.49	0.2
Carp	2	0.09	0.1	1	0.08	<0.1	40	0.43	0.2
Shorthead redhorse	-	-	-	1	0.08	<0.1	37	0.40	0.2
Spottail shiner	3	0.13	0.1	1	0.08	<0.1	32	0.35	0.2
Rainbow smelt	5	0.22	0.2	7	0.59	0.3	30	0.33	0.2
Trout-perch	-	-	-	-	-	-	26	0.28	0.1
Channel catfish	1	0.04	<0.1	2	0.17	0.1	22	0.24	0.1
Longnose gar	-	-	-	-	-	-	13	0.14	0.1
Black redhorse	4	0.18	0.2	4	0.34	0.2	8	0.09	<0.1
Brown bullhead	2	0.09	0.1	-	-	-	7	0.08	<0.1
Chinook salmon	1	0.04	<0.1	-	-	-	6	0.07	<0.1
Goldfish	1	0.04	<0.1	-	-	-	6	0.07	<0.1
Quillback	3	0.13	0.1	1	0.08	<0.1	5	0.05	<0.1
Rainbow trout	1	0.04	<0.1	-	-	-	4	0.04	<0.1
Salmonidae	-	-	-	-	-	-	4	0.04	<0.1
Coho salmon	-	-	-	-	-	-	2	0.02	<0.1
Northern hog sucker	1	0.04	<0.1	-	-	-	2	0.02	<0.1
White crappie	-	-	-	-	-	-	2	0.02	<0.1
Brown trout	-	-	-	-	-	-	1	0.01	<0.1
Northern pike	-	-	-	-	-	-	1	0.01	<0.1
Yellow bullhead	-	-	-	-	-	-	1	0.01	<0.1
Total No. Species	20			16			29		
Total No. Individuals	2228			1183			9198		
Total C/f			92.8			49.3			46.7

Table 2-440 Total Number, Percent Composition, and Mean Catch per Unit Effort (C/f) by Month of Fishes Collected by Shore Seining During the Day (D) and Night (N) at All Stations in Lake Erie near the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April through December 1977.

	APRIL						MAY						JUNE					
	D			N			D			N			D			N		
Species	No.	%	C/f	No.	%	C/f	No.	%	C/f	No.	%	C/f	No.	%	C/f	No.	%	C/f
Emerald shiner	394	51.71	65.7	49	21.40	24.5	33	2.96	2.8	56	10.18	4.7	1258	92.57	104.8	6	8.70	0.5
Spottail shiner	147	19.29	24.5	117	51.09	58.5	807	72.31	67.3	142	25.82	11.8	32	2.35	2.7	10	14.49	0.8
Gizzard shad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rainbow smelt	26	3.41	4.3	11	4.80	5.5	66	5.91	5.5	122	22.18	10.2	3	0.22	0.3	1	1.45	0.1
Striped shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose dace	30	3.94	5.0	-	-	-	26	2.33	2.2	8	1.45	0.7	14	1.03	1.2	5	7.25	0.4
Chinook salmon	137	17.98	22.8	9	3.93	4.5	87	7.80	7.3	24	4.36	2.0	13	0.96	1.1	3	4.35	0.3
Trout-perch	1	0.13	0.2	29	12.66	14.5	24	2.15	2.0	129	23.45	10.8	10	0.74	0.8	23	33.33	1.9
White bass	-	-	-	-	-	-	3	0.27	0.3	1	0.18	0.1	3	0.22	0.3	-	-	-
Coho salmon	12	1.57	2.0	8	3.49	4.0	23	2.06	1.9	53	9.64	4.4	1	0.07	0.1	-	-	-
Logperch	-	-	-	-	-	-	42	3.76	3.5	6	1.09	0.5	22	1.62	1.8	2	2.90	0.2
Brook silverside	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alewife	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quillback	-	-	-	1	0.44	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Sand shiner	2	0.26	0.3	-	-	-	1	0.09	0.1	-	-	-	-	-	-	14	20.29	1.2
Mimic shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel catfish	-	-	-	-	-	-	-	-	-	1	0.18	0.1	-	-	-	1	1.45	0.1
Rainbow trout	6	0.79	1.0	1	0.44	0.5	1	0.09	0.1	3	0.55	0.3	-	-	-	-	-	-
Common shiner	1	0.13	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White sucker	3	0.39	0.5	3	1.31	1.5	-	-	-	-	-	-	-	-	-	-	-	-
Freshwater drum	-	-	-	-	-	-	2	0.18	0.2	1	0.18	0.1	2	0.15	0.2	1	1.45	0.1
Mottled sculpin	-	-	-	-	-	-	1	0.09	0.1	-	-	-	-	-	-	-	-	-
Bluegill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fathead minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4.35	0.3
Stoneroller	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepomis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Largemouth bass	1	0.13	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stonecat	-	-	-	-	-	-	-	-	-	1	0.18	0.1	-	-	-	-	-	-
White crappie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black crappie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Golden shiner	2	0.26	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern hog sucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rock bass	-	-	-	1	0.44	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Rosyface shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shorthead redhorse	-	-	-	-	-	-	-	-	-	1	0.18	0.1	-	-	-	-	-	-
Bigeye chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bluntnose minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Creek chub	-	-	-	-	-	-	-	-	-	1	0.18	0.1	-	-	-	-	-	-
Longnose gar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spotfin shiner	-	-	-	-	-	-	-	-	-	-	-	-	1	0.07	0.1	-	-	-
Yellow perch	-	-	-	-	-	-	-	-	-	1	0.18	0.1	-	-	-	-	-	-
Cyprinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pomoxis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentifiable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Species	13			10			13			16			[illegible]			11		
Total No. Individuals	762			229			1116			550			1359			69		
Total No. C/f			127.0			114.5			93.0			45.8			113.3			5.8
Grand Total Species				15						18						14		
Grand Total Individuals				991						1666						1428		
Grand Total C/f				[illegible]						[illegible]						[illegible]		

Table 2-440 (Continued)

Species	JULY D No.	JULY D %	JULY D C/f	JULY N No.	JULY N %	JULY N C/f	AUGUST D No.	AUGUST D %	AUGUST D C/f	AUGUST N No.	AUGUST N %	AUGUST N C/f	SEPTEMBER D No.	SEPTEMBER D %	SEPTEMBER D C/f	SEPTEMBER N No.	SEPTEMBER N %	SEPTEMBER N C/f
Emerald shiner	47	1.70	2.9	73	11.30	4.6	224	5.14	9.3	14	1.25	0.6	44	5.09	3.1	17	6.83	1.2
Spottail shiner	1315	47.63	82.2	89	13.78	5.6	2583	59.30	107.6	4	0.36	0.2	589	68.17	42.1	5	2.01	0.4
Gizzard shad	1277	46.25	79.8	392	60.68	24.5	1350	30.99	56.3	819	74.84	35.0	4	0.46	0.3	14	5.62	1.0
Rainbow smelt	-	-	-	2	0.31	0.1	3	0.07	0.1	77	6.87	3.2	22	2.55	1.6	177	71.08	12.6
Striped shiner	5	0.18	0.3	10	1.55	0.6	101	2.32	4.2	100	8.92	4.2	95	11.00	6.8	6	2.41	0.4
Longnose dace	21	0.76	1.3	61	9.44	3.8	44	1.01	1.8	46	4.10	1.9	5	0.58	0.4	11	4.42	0.8
Chinook salmon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	1	0.04	0.1	-	-	-	-	-	-	5	0.45	0.2	-	-	-	7	2.81	0.5
White bass	41	1.48	2.6	1	0.15	0.1	10	0.23	0.4	-	-	-	16	1.85	1.1	4	1.61	0.3
Coho salmon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brook silverside	-	-	-	-	-	-	2	0.05	0.1	2	0.18	0.1	61	7.06	4.4	1	0.40	0.1
Alewife	7	0.25	0.4	-	-	-	9	0.21	0.4	7	0.62	0.3	13	1.50	0.9	2	0.80	0.1
Quillback	1	0.04	0.1	-	-	-	13	0.30	0.5	-	-	-	11	1.27	0.8	1	0.40	0.1
Sand shiner	-	-	-	-	-	-	1	0.02	<0.1	-	-	-	-	-	-	-	-	-
Mimic shiner	15	0.54	0.9	1	0.15	0.1	-	-	-	1	0.09	<0.1	-	-	-	-	-	-
Channel catfish	8	0.29	0.5	1	0.15	0.1	1	0.02	<0.1	4	0.36	0.2	-	-	-	-	-	-
Rainbow trout	2	0.07	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common shiner	5	0.18	0.3	4	0.62	0.3	2	0.05	0.1	-	-	-	-	-	-	-	-	-
White sucker	-	-	-	1	0.15	0.1	2	0.05	0.1	3	0.27	0.1	-	-	-	-	-	-
Freshwater drum	2	0.07	0.1	1	0.15	0.1	-	-	-	-	-	-	-	-	-	2	0.80	0.1
Mottled sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.40	0.1
Bluegill	-	-	-	-	-	-	4	0.09	0.2	6	0.54	0.3	-	-	-	1	0.40	0.1
Fathead minnow	1	0.04	0.1	1	0.15	0.1	1	0.02	<0.1	1	0.09	<0.1	1	0.12	0.1	-	-	-
Stoneroller	1	0.04	0.1	1	0.15	0.1	2	0.05	0.1	3	0.27	0.1	-	-	-	-	-	-
Lepomis sp.	-	-	-	-	-	-	3	0.07	0.1	1	0.09	<0.1	-	-	-	-	-	-
Largemouth bass	3	0.11	0.2	-	-	-	-	-	-	1	0.09	<0.1	-	-	-	-	-	-
Stonecat	-	-	-	1	0.15	0.1	-	-	-	1	0.09	<0.1	-	-	-	-	-	-
White crappie	-	-	-	-	-	-	-	-	-	3	0.27	0.1	-	-	-	-	-	-
Black crappie	1	0.04	0.1	-	-	-	-	-	-	1	0.09	<0.1	-	-	-	-	-	-
Carp	1	0.04	0.1	-	-	-	1	0.02	<0.1	-	-	-	-	-	-	-	-	-
Golden shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern hog sucker	-	-	-	-	-	-	-	-	-	1	0.09	<0.1	1	0.12	0.1	-	-	-
Rock bass	-	-	-	1	0.15	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Rosyface shiner	-	-	-	-	-	-	-	-	-	-	-	-	2	0.23	0.1	-	-	-
Shorthead redhorse	-	-	-	1	0.15	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Bigeye chub	-	-	-	-	-	-	-	-	-	1	0.09	<0.1	-	-	-	-	-	-
Bluntnose minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Creek chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose gar	1	0.04	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spotfin shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyprinidae	3	0.11	0.2	4	0.62	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Pomoxis sp.	2	0.07	0.1	1	0.15	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Unidentifiable	1	0.04	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Species	20			18			18			21			13			14		
Total No. Individuals	2761			646			4356			1121			864			249		
Total C/f			172.6			40.4			181.5			46.7			61.7			17.8
Grand Total Species				25						26						17		
Grand Total Individuals				3407						5477						1113		
Grand Total C/f				106.5						114.1						19.8		

Table 2-440 (Continued)

Species	OCTOBER						NOVEMBER						DECEMBER					
	D			N			D			N			D			N		
	No.	%	C/f	No.	%	C/f	No.	%	C/f	No.	%	C/f	No.	%	C/f	No.	%	C/f
Emerald shiner	2122	91.78	151.6	580	78.91	41.4	1457	91.29	104.1	190	17.07	13.6	143	87.73	20.4	56	14.00	8.0
Spottail shiner	83	3.59	5.9	-	-	-	2	0.13	0.1	1	0.09	0.1	-	-	-	15	3.75	2.1
Gizzard shad	87	3.76	6.2	34	4.63	2.4	114	7.14	8.1	845	75.92	60.4	14	8.59	2.0	273	68.25	39.0
Rainbow smelt	-	-	-	83	11.29	5.9	14	0.88	1.0	18	1.62	1.3	2	1.23	0.3	44	11.00	6.3
Striped shiner	-	-	-	-	-	-	-	-	-	-	-	-	2	1.23	0.3	-	-	-
Longnose dace	3	0.13	0.2	7	0.95	0.5	3	0.19	0.2	8	0.72	0.6	1	0.61	0.1	9	2.25	1.3
Chinook salmon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White bass	17	0.74	1.2	28	3.81	2.0	5	0.31	0.4	43	3.86	3.1	-	-	-	-	-	-
Coho salmon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brook silverside	-	-	-	2	0.27	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Alewife	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quillback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sand shiner	-	-	-	1	0.14	0.1	-	-	-	2	0.18	0.1	-	-	-	1	0.25	0.1
Mimic shiner	-	-	-	-	-	-	-	-	-	-	-	-	1	0.61	0.1	-	-	-
Channel catfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rainbow trout	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White sucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Freshwater drum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mottled sculpin	-	-	-	-	-	-	1	0.06	0.1	6	0.54	0.4	-	-	-	1	0.25	0.1
Bluegill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fathead minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stoneroller	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepomis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Largemouth bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stonecat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White crappie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black crappie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Golden shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern hog sucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rock bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosyface shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shorthead redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bigeye chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bluntnose minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.25	0.1
Creek chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose gar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spotfin shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyprinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pomoxis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentifiable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Species	5			7			7			8			6			8		
Total No. Individuals	2312			735			1596			1113			163			400		
Total C/f			165.1			52.5			114.0			79.5			23.3			57.1
Grand Total Species			8						8						10			
Grand Total Individuals			3047						2709						563			
Grand Total C/f			108.8						96.8						40.2			

Table 2-440 (Continued)

	TOTAL						OVERALL TOTAL		
	D			N					
Species	No.	%	C/f	No.	%	C/f	No.	%	C/f
Emerald shiner	5722	37.43	48.1	1041	20.36	9.1	6763	33.15	28.9
Spottail shiner	5558	36.35	46.7	383	7.49	3.3	5941	29.12	25.4
Gizzard shad	2846	18.61	23.9	2397	46.89	20.8	5243	25.70	22.4
Rainbow smelt	136	0.89	1.1	535	10.47	4.7	671	3.29	2.9
Striped shiner	203	1.33	1.7	116	2.27	1.0	319	1.56	1.4
Longnose dace	147	0.96	1.2	155	3.03	1.3	302	1.48	1.3
Chinook salmon	237	1.55	2.0	36	0.70	0.3	273	1.34	1.2
Trout-perch	36	0.24	0.3	193	3.78	1.7	229	1.12	1.0
White bass	95	0.62	0.8	77	1.51	0.7	172	0.84	0.7
Coho salmon	36	0.24	0.3	61	1.19	0.5	97	0.48	0.4
Logperch	64	0.42	0.5	8	0.16	0.1	72	0.35	0.3
Brook silverside	63	0.41	0.5	5	0.10	<0.1	68	0.33	0.3
Alewife	29	0.19	0.2	9	0.18	0.1	38	0.19	0.2
Quillback	25	0.16	0.2	2	0.04	<0.1	27	0.13	0.1
Sand shiner	4	0.03	<0.1	18	0.35	0.2	22	0.11	0.1
Mimic shiner	16	0.10	0.1	2	0.04	<0.1	18	0.09	0.1
Channel catfish	9	0.06	0.1	7	0.14	0.1	16	0.08	0.1
Rainbow trout	9	0.06	0.1	4	0.08	<0.1	13	0.06	0.1
Common shiner	8	0.05	0.1	4	0.08	<0.1	12	0.06	0.1
White sucker	5	0.03	<0.1	7	0.14	0.1	12	0.06	0.1
Freshwater drum	6	0.04	0.1	5	0.10	<0.1	11	0.05	<0.1
Mottled sculpin	2	0.01	<0.1	8	0.16	0.1	10	0.05	<0.1
Bluegill	4	0.03	<0.1	7	0.14	0.1	11	0.05	<0.1
Fathead minnow	3	0.02	<0.1	5	0.10	<0.1	8	0.04	<0.1
Stoneroller	3	0.02	<0.1	4	0.08	<0.1	7	0.03	<0.1
Lepomis sp.	3	0.02	<0.1	1	0.02	<0.1	4	0.02	<0.1
Largemouth bass	4	0.03	<0.1	1	0.02	<0.1	5	0.02	<0.1
Stonecat	-	-	-	3	0.06	<0.1	3	0.01	<0.1
White crappie	-	-	-	3	0.06	<0.1	3	0.01	<0.1
Black crappie	1	0.01	<0.1	1	0.02	<0.1	2	0.01	<0.1
Carp	2	0.01	<0.1	-	-	-	2	0.01	<0.1
Golden shiner	2	0.01	<0.1	-	-	-	2	0.01	<0.1
Northern hog sucker	1	0.01	<0.1	1	0.02	<0.1	2	0.01	<0.1
Rock bass	-	-	-	2	0.04	<0.1	2	0.01	<0.1
Rosyface shiner	2	0.01	<0.1	-	-	-	2	0.01	<0.1
Shorthead redhorse	-	-	-	2	0.04	<0.1	2	0.01	<0.1
Bigeye chub	-	-	-	1	0.02	<0.1	1	<0.01	<0.1
Bluntnose minnow	-	-	-	1	0.02	<0.1	1	<0.01	<0.1
Creek chub	-	-	-	1	0.02	<0.1	1	<0.01	<0.1
Longnose gar	1	0.01	<0.1	-	-	-	1	<0.01	<0.1
Spotfin shiner	1	0.01	<0.1	-	-	-	1	<0.01	<0.1
Yellow perch	-	-	-	1	0.02	<0.1	1	<0.01	<0.1
Cyprinidae	3	0.02	<0.1	4	0.08	<0.1	7	0.03	<0.1
Pomixis sp.	2	0.01	<0.1	1	0.02	<0.1	3	0.01	<0.1
Unidentifiable	1	0.01	<0.1	-	-	-	1	0.01	<0.1
Total No. Species	33			36			41		
Total No. Individuals	15289			5112			20401		
Total C/f			128.5			44.5			87.2
Grand Total Species			41					41	
Grand Total Individuals			20401					20401	
Grand Total C/f			87.2					81.2	

Summary of Gill Net Catch

2.949
Of the six most abundant species, only gizzard shad, yellow perch, and white bass were caught in significant numbers in offshore gill nets (82.8 percent of the total gill net catch). Yellow perch were caught in highest numbers at Stations LE9 (537) with May, June, and July having been the most productive months. Stations LE1, LE4, LE6, and LE7 also yielded relatively high numbers of yellow perch during May, June, and July, each totalling at least 250 individuals. A large number of these yellow perch were ripe indicating that spawning may have been taking place in nearby areas. Ichthyplankton results suggest that spawning grounds may occur in the mouth and lower reaches of Conneaut Creek (an atypical spawning habitat for yellow perch). Gizzard shad were most abundant at Station LE2 (1,293) with highest concentrations occurring in October and November. Gizzard Shad populations were also high at Stations LE3 (278), LE4 (279), LE5 (673), LE6 (280), LE14 (597), and LE15 (271) during October and early November. White bass were most abundant at Station LE2 (136) with highest numbers caught in late October. Stations LE3, LE4, LE8, and LE9 all yielded at least 50 individuals with late October again having been the most productive month.

2.949a
Also relatively common in gill net collections were Freshwater drum (688) Walleye (151) and White sucker (196). Freshwater drum were not most abundant in April, July and August when over 72 percent were collected. The months of August, September and October accounted for over 74 percent of the total Walleye catch while White suckers were caught in about equal numbers (between 20 and 28 per month) from June through November. For each of these species no station exhibited a particularly high collection yield.

2.949b
Sampling involved pulling a 15m seine (6.4mn square mesh) in less than 1.5m of water for approximately 61 meters parallel to shore.

Summary of Nearshore Seine Catch

2.950
In nearshore seine collections, gizzard shad, rainbow smelt, emerald shiner, and spottail shiners were the most abundant species (92.2 percent of total seine catch). Emerald shiners and spottail shiners were caught in the greatest numbers, totalling 8,981 and 6,363, respectively. Over 85 percent of all emerald shiners were collected in the months of June 1977 (1,264), October 1977 (2,702), November 1977 (1,475), and April 1978 (2,213). Stations LE2, LE4, LE5, LE9, LE10, and LE11 all produced over a thousand individuals with LE2 having had the highest total (1,847). Spottail shiners were most abundant at Stations LE4 (2,563), LE9 (909), and LE10 (900) with

the late summer months of July and August representing over 56 percent (3,569) of the total catch. Gizzard shad were also most abundant in late July and early August, and were most common at Stations LE9 (921), and LE10 (1,673). Rainbow smelt were collected in greatest numbers at Station LE2 (196), LE1 (138), and LE5 (83), however, at least 50 or more individuals were caught at each station sampled except LE4. Rainbow smelt were caught during each sampling period but were most numerous during May and September. White bass totalled 176 individuals and were caught in highest numbers at Station LE4 during November.

2.951
For each of the six most abundant fish species, Table 2-441, summarizes the total number of individuals by date and station for both offshore gill net collections and nearshore seine collections.

2.952
Table 2-442 summarizes all species of adult fish by total numbers collected per contour and month sampled. For example, yellow perch is shown to occur most abundantly at middle (15-25-foot contour) and deep (30-foot contour) depths during May, June, and July.

Tributaries

2.953
In general, there was a decrease in species abundance and diversity from the creek mouths upstream and to the tributaries. In the spring and fall especially, the creek mouth locations contained both stream and lake species. The cyprinids were the most abundant species at all Turkey Creek locations. Seasonal patterns are apparent, with May showing the greatest abundance for most species; summer low flow periods, the least; and diversity increasing again during the fall.

Raccoon Creek Sampling Results

2.954
All sampling in Raccoon Creek was done by electroshocking from 21 April to 20 December 1977, and again in March and April 1978 at Stations RC1 and RC2.

2.955
Cyprinidae dominated, comprising over 54 percent (1,840) of the total catch from both sampling stations. Most common cyprinidae species at Station RC1 included emerald shiner (578), spottail shiner (317), and striped shiner (200), while at Station RC2, stoneroller (214), and creek chubs (161) were the most numerous. Emerald shiners were collected primarily in November 1977 and April 1978, while spottail

Table 2-441 Summary of Six Most Abundant Fish Species

Gillnet	Seine

#1 Gizzard Shad

#2 Emerald Shiner

None were collected with gillnets

#3 Spottail Shiner

Table 2-441 cont.

Gillnet	Seine

#4 Yellow Perch

Only a single individual was caught with the shore seine

#5 Rainbow Smelt

#6 White Bass

Table 2-442

Summary of Adult Fish Species
Collected by Gill Netting and Shore
Seining in Lake Erie --
April through November 1977

	April				May				June				July			
	Harbor	Shallow	Middle	Deep	Harbor	Shallow	Middle	Deep	Harbor	Shallow	Middle	Deep	Harbor	Shallow	Middle	Deep
Alewife (Alosa pseudoharengus)										5				2		
Longnose Gar (Lepisosteus osseus)	1								10				1	1		
Gizzard Shad (Dorosoma cepedianum)	6	1			21	4			79	18	5		33	1,399	68	6
Coho Salmon (Oncorhynchus kisutch)	1															
Rainbow Trout (Salmo gairdneri)	1				1											
Brown Trout (Salmo trutta)											1					
Salmonid Sp (2)	76	70			92	23			14							
Rainbow Smelt (Osmerus mordax)	5	24	1		42	41	2	1		1					2	
Northern Pike (Esox lucius)					1											
Emerald Shiner (Notropis atherinoides)	68	326			3	27			1,227	31				47		
Spottail Shiner (Notropis hudsonius)	3	28	1	1	49	669	12	2	16	17				1,315		
Carp (Cyprinus carpio)					10				4	3	2		10	3	2	
Goldfish (Carassius auratus)					1								1	1		
Creek Chub (Semotilus atromaculatus)																
Longnose Dace (Rhinichthys cataractae)		30				26				14				21		
Stoneroller (Campostoma anomalum)														1		
Other Cyprinid Sp (12)		5				1				1				26		
Quillback (Carpiodes cyprinus)		1											1			
Common White Sucker (Catostomus commersoni)		5	5	1	5	3	5	5	6	2	7	12	6	1	10	11
Northern Hog Sucker (Hypentelium nigricans)																
Moxostoma Sp (3)	1	1			6	4			2	1	5	2	4	3	9	
Channel Catfish (Ictalurus punctatus)	1	2			1	2			1		2		4	10		
Other Ictalurids (2)	3				1								4			
Stonecat (Noturus flavus)	3		1		4	2	1		3		9				6	1
Trout Perch (Percopsis omiscomaycus)	1	1	3	3	1	30	11	1	1	10	3			1		
Largemouth Bass (Micropterus salmoides)	1													3		
Smallmouth Bass (Micropterus dolomieui)			1			2	1		1	2	8	5	1	12	9	1
Rock Bass (Ambloplites rupestris)	1		1		1	1	2	2	3	1	4	6	3		2	2
Lepomis Sp (3)																
White Bass (Morone chrysops)					7	8	1		4	4	1		20	30		
Yellow Perch (Perca flavescens)	1		65	60	124	80	573	390	37	6	97	151	27	23	293	495
Walleye (Stizostedion vitreum)		1			1	5				7	7		11	8	2	
Logperch (Percina caprodes)						42				22						
Freshwater Drum (Aplodinotus grunniens)		3	18	7	4	8	[illegible]	4	17	6	52	18	59	37	87	30
Mottled Sculpin (Cottus bairdi)						1										
Pomoxis Sp													1	1		
Brook Silverside (Labidesthes sicculus)																

Table 2-442 (Continued)

	August				September				October				November			
	Harbor	Shallow	Middle	Deep	Harbor	Shallow	Middle	Deep	Harbor	Shallow	Middle	Deep	Harbor	Shallow	Middle	Deep
Alewife (*Alosa pseudoharengus*)	1	9				15										
Longnose Gar (*Lepisosteus osseus*)		1														
Gizzard Shad (*Dorosoma cepedianum*)	228	1,459	179	54	94	208	218	65	555	628	652	157	778	1,097	68	30
Coho Salmon (*Oncorhynchus kisutch*)					1											
Rainbow Trout (*Salmo gairdneri*)	1															
Brown Trout (*Salmo trutta*)	2						1				1					
Salmonid Sp (2)					1	1			1							
Rainbow Smelt (*Osmerus mordax*)		60			12	196			1	20	4	1	5	36	1	
Northern Pike (*Esox lucius*)																
Emerald Shiner (*Notropis atherinoides*)	4	127			14	47			133	2,549			265	1,402		
Spottail Shiner (*Notropis hudsonius*)		2,585	1		13	581		1	2	84						
Carp (*Cyprinus carpio*)	3	1		1							2		1	1		
Goldfish (*Carassius auratus*)			2								1					
Creek Chub (*Semotilus atromaculatus*)																
Longnose Dace (*Rhinichthys cataractae*)	5	71				15				1			1	10		
Stoneroller (*Campostoma anomalum*)		2														
Other Cyprinid Sp (12)	22	103			83	22							1	3		
Quillback (*Carpiodes cyprinus*)	13					12			1		2				1	
Common White Sucker (*Catostomus commersoni*)	2	13	7	5	1	5	15	7	3	5	12	1	3	1	13	7
Northern Hog Sucker (*Hypentelium nigricans*)		1				1				1						
Moxostoma Sp (3)	2	4	9	2		8	8	2	1	5	7	2	2	8	3	
Channel Catfish (*Ictalurus punctatus*)			1	2				1	1			1				2
Other Ictalurids (2)									2							
Stonecat (*Noturus flavus*)		1	5	3	1		3									
Trout Perch (*Percopsis Omiscomaycus*)					4	3										
Largemouth Bass (*Micropterus salmoides*)																
Smallmouth Bass (*Micropterus dolomieui*)		6	11	4	1	2	2				1				1	
Rock Bass (*Ambloplites rupestris*)	3	1	5	4		1	3	1			1	1			1	1
Lepomis Sp (3)		43														
White Bass (*Morone chrysops*)	50	13	14	12	36	42	133	42	55	40	89	54	33	63	44	10
Yellow Perch (*Perca flavescens*)	18	8	86	134	17	8	59	54	14	3	12	5	5	1	15	5
Walleye (*Stizostedion vitreum*)		13	16	24		8	16	5		13	10	4		2	2	1
Logperch (*Percina caprodes*)		1														
Freshwater Drum (*Aplodinotus grunniens*)	44	15	40	38	2	1	8	3			6	8			1	2
Mottled Sculpin (*Cottus bairdi*)						1								7		
Pomoxis Sp	1															
Brook Silverside (*Labidesthes sicculus*)	1	3			45	17	2	1								

Key: 6-10 Feet, Harbor = (H) Gill nets at LE2 and LE3; Beach seining at LE2.
10 Feet, Shallow = (S) Gill nets at LE5, LE11, LE14, All other beach seining.
15-25 Feet, Middle = (M) Gill nets at LE4, 6, 7, 8, 12 and 15.
30 Feet, Deep = (D) Gill nets at LE1, LE9, LE10, LE13.

Source: Modifield from Aquatic Ecology Associates

shiners were found almost entirely in April. Striped shiners, stonerollers, and creek chub were most abundant in September, although significant numbers did appear in random months. Emerald shiners and striped shiners are considered transient to Raccoon Creek, while spottail shiners, stonerollers, and creek chubs are resident species.

2.956
The catostomidae family represented 16 percent (533) of the total catch from Raccoon Creek. White sucker dominated, particularly at Station RC1 (340 of 381), where their numbers were highest during May 1977. The northern hog sucker, second in numbers to the white sucker, was collected primarily at Station RC2 (117 of 135) during April 1977 and 1978.

2.957
Gizzard shad was the third most abundant fish (254) collected in Raccoon Creek, yet it was taken in only one collection at RC1 during December of 1977. These fish were primarily young-of-the-year. The gizzard shad may inhabit any type of lentic environment and is able to tolerate waters which are quite silty (Miller, 1960). In Lake Erie, this species, primarily young-of-the-year, tends to congregate in protected bays and mouths of tributaries during the late summer and early fall (Miller, 1960; Bodola, 1966). This species is not a resident of Raccoon Creek and falls into the classification of transient.

2.958
Salmonidae comprised over two percent (73) of the adult catch for Raccoon Creek. Coho and rainbow trout represented the majority of salmonids caught, 34 and 31, respectively. Both of these species are considered migrants to Raccoon Creek. Coho were caught almost entirely at Station RC1 (33) while rainbows were in about equal numbers at both stations. Coho, caught predominently in the spring months, were smolts (26) which were stocked by the Pennsylvania Fish Commission. Rainbow trout were most abundant during the spring and fall and were found in Raccoon Creek as either strays or migrants. Data did not indicate the presence of a resident stream population near the two sampling stations. Instead, individuals found appeared to be those that utilize large bodies of water to grow and mature and then ascend tributary streams to spawn.

2.959
Tables 2.443 and 2.444 summarize Raccoon Creek fish collection.

Turkey Creek

2.960
Eleven sampling stations were electroshocked from 19 April 1977 to 21 December 1977, and again in March and April 1978. Sampling efforts

Table 2-443 Total Number of Fishes Collected by Electroshocking from Raccoon Creek (RC) at the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, April 21 to December 20, 1977.

Species	STATION RC1	RC2	Total
Petromyzontidae			
American brook lamprey	8	-	8
Clupeidae			
Gizzard shad	254	-	254
Salmonidae			
Coho salmon	31	1	32
Chinook salmon	4	-	4
Rainbow trout	13	12	25
Brown trout	2	1	3
Oncorhynchus sp.	1	-	1
Cyprinidae			
Stoneroller	6	196	202
Goldfish	1	-	1
Carp	2	-	2
Silverjaw minnow	4	26	30
Bigeye chub	13	2	15
Golden shiner	5	1	6
Emerald shiner	329	-	329
Striped shiner	179	36	215
Common shiner	47	2	49
Spottail shiner	25	-	25
Spotfin shiner	1	1	2
Sand shiner	32	-	32
Mimic shiner	9	3	12
Bluntnose minnow	62	54	116
Fathead minnow	7	7	14
Blacknose dace	-	6	6
Longnose dace	4	2	6
Creek chub	16	147	163
Catostomidae			
White sucker	332	37	369
Northern hog sucker	17	103	120
Silver redhorse	1	-	1
Golden redhorse	6	4	10
Shorthead redhorse	2	1	3
Mosoxtoma sp.	1	-	1
Ictaluridae			
Brown bullhead	6	-	6
Percichthyidae			
White bass	7	-	7

Table 2-443 (Continued)

Species	STATION RC1	RC2	Total
Centrarchidae			
Rock bass	9	3	12
Pumpkinseed	64	5	69
Bluegill	13	3	16
Smallmouth bass	13	3	16
Largemouth bass	7	4	11
Lepomis hybrid	-	1	1
Percidae			
Rainbow darter	2	181	183
Fantail darter	-	8	8
Johnny darter	45	29	74
Logperch	79	-	79
Cottidae			
Mottled sculpin	2	146	148
Total No. Taxa	41	30	44
Total No. Individuals	1661	1025	2686

Table 2-444 Total Number of Fish Collected by Electroshocking from Raccoon Creek (RC) at the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, March-April 1978.

	STATION		
Taxa	RC1	RC2	Total
Petromyzontidae			
American brook lamprey	-	1	1
Salmonidae			
Coho salmon	2	-	2
Rainbow trout	2	4	6
Cyrpinidae			
Stoneroller	-	18	18
Goldfish	1	-	1
Bigeye chub	2	-	2
Golden shiner	1	-	1
Emerald shiner	249	-	249
Striped shiner	21	7	28
Spottail shiner	292	-	292
Sand shiner	4	-	4
Mimic shiner	3	-	3
Bluntnose minnow	5	2	7
Fathead minnow	1	-	1
Creek chub	4	14	18
Catostomidae			
White sucker	8	4	12
Northern hog sucker	1	14	15
Black redhorse	2	-	2
Percichthyidae			
White bass	1	-	1
Centrarchidae			
Rock bass	1	-	1
Percidae			
Rainbow darter	1	24	25
Fantial darter	-	2	2
Johnny darter	5	6	11
Yellow perch	2	-	2
Cottidae			
Mottled sculpin	-	29	29
Total Number Taxa	21	12	25
Total Number Individuals	608	125	733

produced 11,165 individuals represented by 52 taxa from 12 families.

2.961
As in Raccoon Creek, cyprinidae was the most common family (78 percent of all fish caught) in Turkey Creek. Emerald shiner, the most abundant fish specie (43 percent of all fish), was caught at Station TC1 only and primarily in November 1977 and April 1978. This specie is a transient to Turkey Creek as the young-of-the-year characteristically concentrate in nearshore areas during the fall season. Creek chub, second in total numbers (1,260), were found most commonly at Stations TC2, TC3, TC4, and TCT2 during late summer and early fall. The majority were small individuals ($\leq$ 80 mm in total length) indicating they were young-of-the-year or one-year olds (Trautman, 1957). Creek chubs are residents of Turkey Creek. Other cyprinidae found in high numbers included striped shiner (853), bluntnose minnow (1,004), and stoneroller (135).

2.962
Percidae, the second most abundant family (7.9 percent) was dominated by rainbow darter (346), and Johnny darter (492). Found mostly at Stations TC2 and TC3, their preferred habitat, both species exhibited peak abundance in the spring of 1977 and 1978, however, Johnny darter had a secondary peak in early September. Each are resident species.

2.963
Centrarchidae represented 4.4 percent of the total collection with bluegill (104), largemouth bass (160), and pumpkinseed (136) having been the most abundant species. TC1 and TCT2 were the most productive stations for pumpkinseeds and bluegills, while TC4, TC1, and TCT2 were high yield stations for largemouth bass. Pumpkinseed were most common in May, bluegill in September, and largemouth bass in July. Pumpkinseed and blue gills are resident species while largemouth bass are considered transients as the majority collected were young-of-the-year probably utilizing the creek as a nursery area.

2.964
The esocidae family was represented by significant numbers of grass pickerel (123), particularly at Station TC4 (37) and Station TCT5 (52). A majority were taken from 31 May to 2 June, and were young-of-the-year indicating recent spawning. Stations TCT5 and TCT6 are characterized by the preferred habitat of grass pickeral (i.e., clear, densely vegetated, low gradient streams). This species is a resident of Turkey Creek.

2.965
Salmonidae represented 3.1 percent (345) of the fish collected in Turkey Creek. Station TC3 produced 64.6 percent (223) of all salmonids caught with rainbow trout accounting for 221. For all stations

sampled, rainbow trout totalled 301 individuals, most of which were collected in April and May. Most rainbows caught were small, less than 102mm in length, however, a significant number of adults were also caught. Several spring residents and migrants ranged from 192-695mm while fall run individuals ranged from 135 to 670 mm in total length. Collection sites included TC3, TC4, TC3.5 and TCT2. The relatively high number of rainbow trout has been attributed to the Ohio stocking program for Turkey Creek. Coho salmon, the second most abundant salmonid in Turkey Creek, was collected entirely at Station TC1 during the spring and fall of 1977. Of the 31 individuals collected, 26 were smolts stocked by the Pennsylvaniua Fish Commission at points east of Turkey Creek. Five adult cohos were collected, four of which were ripe males found in the fall. Brown trout were also collected, but in very low numbers. Those that occurred in Raccoon Creek were considered strays. Tables 2-445 and 2-446 lists all species collected in Turkey Creek by station.

2.966
Spawning success for salmonids has been determined marginal. Only a single redd was located during the study near Station TCT2, however, before a monitoring program could be set up and implemented, severe winter weather destroyed the site. An alternative plan to set up drift nets was developed to capture successful salmonid ichthyoplankton and juveniles. Nets were deployed from 10 May to 16 June 1978, for a total of 904 hours. Little success resulted from this effort, as the only salmonids taken were two rainbow trout.

2.967
With the fish development season progressing rapidly, a final alternative to electroshock in conjunction with drift nets was employed at seven locations on three dates. A one-year old smolt chinook salmon was collected at Station TC1 on 13 June 1978. Its origin is unknown, but its occurrence may be a result of stocking activities conducted by the Commonwealth of Pennsylvania at points east of Turkey Creek. Rainbow trout were collected at Stations TC1, TC3, TCT2a, TCT2b, and TCT2c. Fifteen of the rainbow trout were one-year olds and ranged in total length from 82 to 162 mm. These individuals were probably the result of stocking efforts at Station TC3 by the State of Ohio (V. LaConte, personal communication).

Table 2-445 Total Number of Fishes Collected by Electroshocking from Turkey Creek (TC) and Turkey Creek Tributaries (TCT) at the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, April 19 to December 21, 1977.

	STATION												
Species	TC1	TC2	TC3	TC3.5	TC4	TCT1	TCT2	TCT3	TCT4	TCT5	TCT6	TCT7	Total
Clupeidae													
Gizzard shad	1	-	-	-	-	-	-	-	-	-	-	-	1
Salmonidae													
Coho salmon	30	-	1	5	-	-	2	-	-	-	-	-	38
Chinook salmon	4	-	-	-	-	-	1	-	-	-	-	-	5
Rainbow trout	22	7	138	2	6	12	1	-	-	-	-	-	188
Brown trout	-	1	1	-	-	-	-	-	-	-	-	-	2
Oncorhynchus spp.	1	-	-	-	-	-	-	-	-	-	-	-	1
Osmeridae													
Rainbow smelt	1	-	-	-	-	-	-	-	-	-	-	-	1
Umbridae													
Central mudminnow	-	-	2	1	5	-	10	-	-	-	-	-	18
Esocidae													
Grass pickerel	1	1	5	1	37	-	4	-	-	52	10	-	111
Northern pike	2	-	-	-	-	-	-	-	-	-	-	-	2
Cyprinidae													
Stoneroller	7	24	67	1	20	2	6	-	-	-	-	-	127
Carp	2	1	1	-	-	-	-	-	-	-	-	-	4
Bigeye chub	10	2	4	-	-	-	-	-	-	-	-	-	16
Golden shiner	2	-	-	1	1	-	3	-	-	-	-	-	7
Emerald shiner	4387	-	-	-	-	-	-	-	-	-	-	-	4387
Striped shiner	80	127	268	6	167	39	40	-	-	-	-	3	730
Common shiner	8	6	14	-	-	-	-	-	-	-	-	-	28
Spottail shiner	11	-	-	-	-	-	-	-	-	-	-	-	11
Spotfin shiner	-	-	-	-	1	-	-	-	-	-	-	-	1
Sand shiner	36	3	4	-	-	-	-	-	-	-	-	-	43
Mimic shiner	5	1	1	-	-	-	-	-	-	-	-	-	7
Bluntnose minnow	177	279	404	1	1	5	-	-	-	-	-	-	867

Table 2-445 (Continued)

Species	TC1	TC2	TC3	TC3.5	TC4	TCT1	TCT2	TCT3	TCT4	TCT5	TCT6	TCT7	Total
	STATION												
Cyprinidae (Cont'd.)													
Fathead minnow	6	2	2	-	-	-	6	-	-	-	-	-	16
Blacknose dace	-	-	-	-	2	-	10	-	-	-	-	-	12
Longnose dace	1	-	9	-	1	-	-	-	-	-	-	-	11
Creek chub	1	477	266	6	131	58	223	-	-	2	-	3	1167
Catostomidae		2*			10*								12*
Quillback	2	-	-	-	-	-	-	-	-	-	-	-	2
White sucker	120	151	93	8	55	3	1	-	-	7	-	-	438
Northern hog sucker	2	13	9	-	3	-	-	-	-	-	-	-	27
Black redhorse	-	-	1	-	-	-	-	-	-	-	-	-	1
Golden redhorse	4	2	7	1	-	-	-	-	-	-	-	-	14
Shorthead redhorse	1	1	4	-	-	-	-	-	-	-	-	-	6
Ictaluridae													
Black bullhead	-	-	-	-	-	-	6	-	-	-	-	-	6
Brown bullhead	5	1	-	-	3	-	8	-	-	-	-	-	17
Ictalurus hybrid	-	-	-	-	-	-	1	-	-	-	-	-	1
Percichthyidae													
White bass	1	-	-	-	-	-	-	-	-	-	-	-	1
Centrarchidae													
Rock bass	3	-	-	-	-	-	-	-	-	-	-	-	3
Green sunfish	21	3	3	1	4	1	30	-	-	2	-	-	65
Pumpkinseed	73	4	11	6	5	1	32	-	-	2	1	-	135
Bluegill	44	5	10	2	7	2	25	-	-	8	-	-	103
Smallmouth bass	6	2	-	1	8	-	1	-	-	-	1	-	19
Largemouth bass	36	9	27	4	41	-	32	-	-	7	4	-	160
Lepomis hybrid	1	1	-	-	-	-	-	-	-	-	-	-	2
Lepomis sp.	-	-	-	-	1	-	-	-	-	-	-	-	1
Percidae													
Rainbow darter	-	136	173	-	3	-	8	-	-	-	-	-	320
Fantail darter	-	3	-	-	-	-	-	-	-	-	-	-	3
Johnny darter	26	236	149	1	35	2	7	-	-	-	-	-	456

Table 2-445 (Continued)

Species	TC1	TC2	TC3	TC3.5	TC4	TCT1	TCT2	TCT3	TCT4	TCT5	TCT6	TCT7	Total
	STATION												
Percidae (Cont'd.)													
Yellow perch	1	-	-	-	-	-	-	-	-	-	-	-	1
Log perch	36	2	-	-	-	-	-	-	-	-	-	-	38
Sciaenidae													
Freshwater drum	1	-	-	-	-	-	-	-	-	-	-	-	1
Total Number of Taxa	40	29	27	17	23	10	22	0	0	7	4	2	51
Total Number of Individuals	5178	1502	1674	48	547	125	457	0	0	80	16	6	9633

* These individuals were larvae which were collected by electroshocking gear and could not be identified below this taxonomic unit.

Table 2-446 Total Number of Fishes Collected from Turkey Creek (TC) and its Tributaries (TCT) at Stations TC1 through TC4 and TCT1 through TCT6 by Electroshocking at the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, March-April 1978.

	STATION											
Taxa	TC1	TC2	TC3	TC3.5	TC4	TCT1	TCT2	TCT3	TCT4	TCT5	TCT6	Total
Salmonidae												
Coho salmon	1	-	-	-	-	-	-	-	-	-	-	1
Rainbow trout	4	3	83	9	3	-	11	-	-	-	-	113
Umbridae												
Central mudminnow	-	-	-	-	1	-	-	-	-	-	-	1
Esocidae												
Grass pickerel	-	-	-	-	-	-	1	-	-	-	11	12
Cyprinidae												
Stoneroller	-	-	-	-	-	8	-	-	-	-	-	8
Goldfish	23	-	-	-	-	-	-	-	-	-	-	23
Carp	2	-	-	-	-	-	-	-	-	-	-	2
Bigeye chub	2	-	-	-	-	-	-	-	-	-	-	2
Golden shiner	1	-	1	8	1	-	18	-	-	3	1	33
Emerald shiner	429	-	-	-	-	-	-	-	-	-	-	429
Striped shiner	-	14	9	21	48	25	6	-	-	-	-	123
Common shiner	-	1	-	-	-	-	-	-	-	-	-	1
Spottail shiner	503	-	-	-	-	-	-	-	-	-	-	503
Spotfin shiner	1	-	-	-	-	-	-	-	-	-	-	1
Sand shiner	2	-	-	-	-	-	-	-	-	-	-	2
Bluntnose minnow	26	8	3	-	-	-	-	-	-	-	-	37
Blacknose dace	-	-	-	-	-	-	1	-	-	-	-	1
Creek chub	-	1	2	10	5	21	53	-	-	1	-	93
Catostomidae												
White sucker	31	9	-	8	5	3	13	-	-	1	1	71
Black redhorse	3	-	-	-	-	1	-	-	-	-	-	4
Percichthyidae												
White bass	1	-	-	-	-	-	-	-	-	-	-	1
Centrarchidae												
Green sunfish	-	1	-	-	-	-	1	-	-	2	-	4
Pumpkinseed	-	-	-	-	-	-	-	-	-	1	-	1
Bluegill	1	-	-	-	-	-	-	-	-	-	-	1

Table 2-446 (Continued)

Taxa	TC1	TC2	TC3	TC3.5	TC4	TCT1	TCT2	TCT3	TCT4	TCT5	TCT6	Total
	STATION											
Percidae												
Rainbow darter	-	2	21	-	-	-	3	-	-	-	-	26
Johnny darter	1	7	10	6	11	1	-	-	-	-	-	36
Yellow perch	2	-	-	-	-	-	-	-	-	-	-	2
Sciaenidae												
Freshwater drum	1	-	-	-	-	-	-	-	-	-	-	1
Total Number Taxa	18	9	7	6	7	6	9	0	0	5	3	28
Total Number Individuals	1034	46	129	62	74	59	107	0	0	8	13	1532

2.968
The remaining seven rainbow trout were young-of-the-year collected at Stations TCT2a, TCT2b, and TCT2c on 13 and 16 June 1978. They ranged in total length as follows:

Station	Date	Total Length mm
TCT2a	6-13	43
		35
TCT2b	6-13	39
TCT2a	6-16	39
		31
		30
TCT2c	6-16	36

2.969
An attempt was made to take scales for aging, however, no scales were present. Absence of scales and their small size indicates they were young-of-the-year fish and provides evidence of natural reproduction of rainbow trout in Turkey creek. Their identity was verified by the Ohio State University Museum.

2.970
Judging from the all-season sampling program, which included a full compliment of sites typifying the stream's physical characteristics, the applicant concluded that the Turkey Creek watershed is not generally suited for successful salmonid reproduction. The section of Turkey Creek tributary within which young-of-the-year rainbow trout were found during this effort represents approximately 3.5 percent of the total length of the streams in the watershed. The comparative lack of success in obtaining greater numbers of young-of-the-year for the effort expended indicates that the spawning success in the areas sampled is very slight and is of no apparent importance to the overall fisheries potential of Lake Erie. Corps staff feels that although natural salmonid production probably persists at only insignificant levels, the potential for improving salmonid habitat and consequential improved reproduction success may be a realistic fishery management objective.

Conneaut Creek

2.971
In Conneaut Creek, stations CC1 and CC2 were sampled by electroshocking and gill nets, while Station CC3 was sampled by electroshocking only. Collection results totalled 12,557 individuals represented by 47 species from 17 families.

2.972
Gizzard shad dominated, comprising 54 percent (6,789) of the total catch. Although collected at each station and by both sampling methods, electroshocking at Station CC2 produced more than 79 percent (5,394) of all gizzard shad caught. All of these individuals (a majority juveniles) were caught in October and November 1977. Sampling data indicated that gizzard shad are a spring and fall transient to lower Conneaut Creek.

2.973
The family cyprinidae accounted for 33.6 percent (4,224) of the total catch. The most common species were bigeye chub (794), emerald shiner (741), striped shiner (642), and bluntnose minnow (674). Station CC3 accounted for nearly 73 percent of all cyprinids collected. Of the most common species, only striped shiner and emerald shiner dominated at CC2. Highest numbers of cyprinids were collected in late summer months.

2.974
Percidae, the third most abundant family (3.4 percent), was dominated by the rainbow darter (149) and the greenside darter (124). Both of these species were found entirely at Station CC3 and most commonly during the spring months.

2.975
Salmonids in Conneaut Creek represented only 0.41 percent (52) of the total catch. Coho salmon accounted for nearly 52 percent (27) of the salmonid collected. A total of five Coho salmon were collected in lower Conneaut Creek in 1977. None were collected upstream of Station CC3. In the spring of 1978, a total of 22 were collected in lower Conneaut Creek and, as in 1977, none were collected at Station CC3. Those collected in the spring were not smolts as were collected in Turkey and Raccoon Creeks, but were one and two-year olds ranging in total length from 162 to 435 mm. The coho salmon collected in 1978 were all three or four years old ranging in total length from 376 to 487 mm. The coho salmon collected in 1977 and 1978 were not stocked by the State of Ohio because the last stocking of Coho salmon in Conneaut Creek occurred in 1972 (V. LaConte, personnel communication). Large numbers were not collected in the fall of 1977 indicating that no large influx of spawning adults occurs in Conneaut Creek. Their occurrence in Conneaut Creek is a result of straying from Lake Erie. It is interesting to note that the smolts collected in Turkey and Raccoon Creeks were not collected in Conneaut Creek. Apparently the range of the nearshores smolt straying (after being released in Pennsylvania) before they seek deeper waters, does not extend beyond Conneaut, Ohio.

2.976
Chinook salmon and rainbow trout were also caught (10 and 14, respectively). Of these individuals, only two rainbow trout were colleted at Station CC3. Station CC1 yielded six chinook and three rainbow while Station CC2 produced four chinook and nine rainbows. Chinook salmon were all strays from lake Erie and except for two spring migrants (in spawning condition) rainbow trout were all strays.

2.977
Tables 2-447 and 2-448 list all species collected in Conneaut Creek.

Protected Fish Species

2.978
Several fish species that are afforded protection by either Ohio or Pennsylvania were captured. The black bullhead has been collected in both Conneaut Creek and the Pennsylvania portions of Turkey Creek. This species has an "indeterminant status" level of protection in Pennsylvania. Surveys by the U.S. Fish and Wildlife Service confirmed the existence of Sea Lamprey ammocoetes in several locations in Conneaut Creek and Raccoon Creek, but not Turkey Creek. This species has an "indeterminant" status in the Commonwealth of Pennsylvania. A number of longnose dace have been captured in both Ohio and Pennsylvania waters. This species has been proposed for protection by the Ohio Historical Society for reasons unknown as of this writing. The orange-spotted sunfish, possibly captured in the Ohio waters of Turkey Creek, has an "indeterminant" status in Pennsylvania. A sauger was captured in the harbor area. This species also has an "indeterminant" status in Pennsylvania, but is stocked by Ohio. Two muskellunge were captured in Conneaut Creek. A subspecies is protected by Ohio, but it is not determined whether either of the two individuals captured belonged to this subspecies, which is not recognized by the American Fisheries Society. Two mooneye (Hiodon tergisus) were collected in April 1978, one in the mouth of Conneaut Creek (CC1) and one in Conneaut Harbor (LE2). This species is considered endangered in Ohio.

Small Pond
2.979
A small pond (P1) located in dense brush, southeast of the intersection of State Line and Lake Roads, was approximately three meters wide and five meters long with a maximum depth of 0.5 meter. Prior to sampling, bubbles (presumably methane gas) were observed rising from numerous areas of the substrate (organic muck). The water was clear and no inlets or outlets were visible. The pond (P1) was extensively sampled on 19 April resulting in no fish having been observed or collected.

Table 2-447 Total Number of Fishes Collected by Gill Netting and Electroshocking in Conneaut Creek (CC) at the Proposed U.S. Steel Lakefront Plant Site, Conneaut, Ohio, April 19 to November 29, 1977.

Taxa	STATION CC1	CC2	CC3	Total
Lepisosteidae				
Longnose gar	-	4	5	9
Clupeidae				
Alewife	2	1	-	3
Gizzard shad	1153	5625	10	6788
Salmonidae				
Coho salmon	3	2	-	5
Chinook salmon	6	4	-	10
Rainbow trout	2	7	2	11
Brown trout	-	1	-	1
Osmeridae				
Rainbow smelt	1	-	-	1
Umbridae				
Central mudminnow	-	-	1	1
Esocidae				
Grass pickerel	-	-	18	18
Muskellunge	-	2	-	2
Cyprinidae		2*		2*
Stoneroller	-	2	343	345
Goldfish	16	1	-	17
Carp	17	17	2	36
Bigeye chub	6	322	409	737
River chub	-	1	68	69
Golden shiner	5	4	-	9
Emerald shiner	62	40	4	106
Striped shiner	29	388	175	592
Common shiner	-	4	129	133
Spottail shiner	13	1	7	21
Rosyface shiner	-	5	80	85
Spotfin shiner	-	6	63	69
Sand shiner	2	14	52	68
Mimic shiner	14	62	95	171
Bluntnose minnow	24	103	464	591
Fathead minnow	1	1	13	15
Creek chub	-	-	1	1
Carp-Goldfish hybrid	2	-	-	2
Notropis spp.	-	1	26	27
Nocomis sp.	-	-	1	1

Table 2-447 (Continued)

Taxa	CC1	CC2	CC3	Total
		STATION		
Catostomidae				
Quillback	8	2	-	10
White sucker	18	10	59	87
Northern hog sucker	-	8	22	30
Silver redhorse	1	-	-	1
Black redhorse	3	29	-	32
Golden redhorse	42	59	17	118
Shorthead redhorse	6	21	1	28
Moxostoma sp.	-	-	3	3
Ictaluridae				
Black bullhead	6	-	1	7
Yellow bullhead	1	-	3	4
Brown bullhead	20	2	3	25
Channel catfish	7	9	-	16
Stonecat	4	-	8	12
Percopsidae				
Trout-perch	1	-	-	1
Atherinidae				
Brook silverside	1	-	-	1
Percichthyidae				
White bass	60	32	-	92
Centrarchidae				
Rock bass	3	25	42	60
Green sunfish	2	3	5	10
Pumpkinseed	10	45	20	75
Bluegill	11	24	40	75
Longear sunfish	-	-	1	1
Smallmouth bass	-	9	41	50
Largemouth bass	12	31	1	44
White crappie	8	1	-	9
Black crappie	4	1	1	6
Lepomis hybrid	6	4	-	10
Percidae				
Greenside darter	-	-	117	117
Rainbow darter	-	-	141	141
Fantail darter	-	-	11	11
Johnny darter	-	5	33	38
Yellow perch	57	5	1	63
Logperch	-	11	-	11
Blackside darter	-	-	4	4
Sauger	2	-	-	2
Walleye	7	4	-	11
Sciaenidae				
Freshwater drum	41	15	-	56
Total No. Taxa	44	48	45	67
Total No. Individuals	1699	6963	2545	11207

*These individuals were larvae and could not be identified.

Table 2-448 Total Number of Fish Collected by Gill Netting and Electroshocking from Conneaut Creek (CC) Stations CC1, CC2, and CC3 at the Proposed U. S. Steel Lakefront Plant Site, Conneaut, Ohio, April 1978.

	STATION			
Taxa	CC1	CC2	CC3	Total
Petromyzontidae				
American brook lamprey	1	-	-	1
Clupeidae				
Gizzard shad	1	-	-	1
Hiodontidae				
Mooneye	1	-	-	1
Salmonidae				
Coho salmon	13	9	-	22
Rainbow trout	1	2	-	3
Cyprinidae				
Stoneroller	-	1	24	25
Goldfish	17	1	-	18
Carp	4	2	1	7
Carp x Goldfish hybrid	1	-	-	1
Bigeye chub	14	3	40	57
River chub	-	-	4	4
Golden shiner	1	-	-	1
Emerald shiner	147	488	-	635
Striped shiner	11	16	23	50
Spottail shiner	124	71	-	195
Rosyface shiner	-	-	10	10
Spotfin shiner	1	-	3	4
Sand shiner	-	5	-	5
Mimic shiner	-	4	28	32
Bluntnose minnow	15	17	51	83
Catostomidae				
Quillback	-	1	-	1
White sucker	40	7	5	52
Northern hog sucker	-	1	2	3
Black redhorse	31	9	9	49
Golden redhorse	16	5	1	22
Shorthead redhorse	2	2	-	4

Table 2-448 (Continued)

Taxa	CC1	CC2	CC3	Total
Ictaluridae				
Brown bullhead	3	1	-	4
Channel catfish	1	-	-	1
Percopsidae				
Trout-perch	-	3	-	3
Percichthyidae				
White bass	4	-	-	4
Centrarchidae				
Rock bass	-	2	8	10
Pumpkinseed	2	-	1	3
Smallmouth bass	1	1	-	2
Percidae				
Greenside darter	-	-	7	7
Rainbow darter	-	-	7	7
Fantail darter	-	-	11	11
Johnny darter	-	-	3	3
Walleye	2	2	-	4
Scianeidae				
Freshwater drum	5	-	-	5
Total No. Taxa	26	23	19	39
Total No. Individuals	459	653	238	1350

Protected Species

Terrestrial Species

a) Species Protected by Federal Law

2.980
The plant and animal species which are Federally protected and which have known ranges in Ohio or Pennsylvania are listed in Table 2-449.

b) Federal Protected Species Which May Inhabit the Region

2.981
Of these species, many would not be expected to inhabit the Regional Study Area. The field chickweed, for example, is known only in Chester County, Pennsylvania, at the opposite corner of the State. (2-261) The pogonia, though rare, may be found in the area from May to early July, most likely in small colonies located in dry woodland areas. Heart-leaf plantain could be found in the more swampy areas or in and along streams. It has been recorded in Adams, Auglaize, Erie, Franklin, Logan, Lorain, Lucas, and Madison Counties in Ohio (2-262). Pinkweed may be found later in the summer especially in calcareous areas as has been reported in Ottawa County, Ohio, and elsewhere along the Lake Erie shoreline. The globeflower is usually found in rich meadows or swamps during April and May (2-261). It has been identified in Edinboro Swamp, Erie County, Pennsylvania. (2-263) Reed bentgrass is a recently discovered species, found on dry cliffs in Ofer Hollow, Jackson County, Ohio (2-262) and Vinton County. (2-264) It is not known whether it might be found nearer to the project site.

2.982
The cougar generally prefers rugged mountain areas uninhabited by humans, so is not likely to be found in this region. There were two active bald eagle nests at Pymatuning Lake and one near Geneva, Pennsylvania, in Conneaut Marsh. Also, one was reported in Ashtabula County, 2-1/4 miles south of the project site (2-265). Although nesting activities have been hampered by curious spectators, recent public access restrictions have been instituted to encourage the birds to stay. The Pennsylvania nest produced three eaglets in 1976, which is more than any year since 1964. No bald eagles have been observed migrating near the site since 1974. (2-266) During March 1977, the Geneva nest was toppled by heavy winds. At that time, the female was incubating two eggs. Two eggs were subsequently laid in an artificial nest built by the Pymatuning game manager but were apparently eaten by a raccoon. The second Pennsylvania nest produced one egg which was eaten or otherwise destroyed. The third nest produced one egg, but it is not known whether it was fertile. (2-265)

Table 2-449

Ohio and Pennsylvania Species Protected by Federal Law

Scientific Name	Common Name	Known Range
Plants		
1. Cerastium arvense var. villosissimum	Field chickweed (unnamed)	Pennsylvania
2. Scirpus ancistrochaetus	Bulrush (unnamed)	Pennsylvania, Vermont, New York, Virginia
3. Elodea schweinitzii	Waterweed, Schweinitz's	Pennsylvania
4. Isotria medeoloides	Pogonia, small whorled	Rhode Island, Vermont, Massachusetts, New York, Connecticut, Pennsylvania, Virginia, Illinois, New Jersey, North Carolina, Michigan, Maine, New Hampshire
5. Plantago cordata	Plantain, heart-leaf	Georgia, Illinois, Mississippi, New York, North Carolina, Ohio
6. Calamagrostis insperata	Reed bentgrass (unnamed)	Ohio, Missouri
7. Polygonum pensylvanium var. eglandulosum	Pennsylvania Smartweed	Ohio
8. Trollius laxus	Globeflower, spreading	Connecticut, New York, Pennsylvania, Delaware, Ohio, New Hampshire, Maine, New Jersey
Animals		
Felis concolor cougar	Cougar, eastern	Eastern U.S
Myotis sodalis	Bat, Indiana	Eastern and Midwestern U.S
Haliaeetus leucocephalus	Eagle, Southern bald	South of 40th Parallel
Falco peregrinus anatum	Falcon, American peregrine	U.S.A.
Falco peregrinus tundrius	Falcon, arctic peregrine	U.S.A.
Dendroica kirtlandii	Warbler (wood), Kirtland's	U.S.A.
Coregonus alpenae	Cisco, longjaw	Lakes Michigan, Huron & Erie
Noturus trautmani	Madtom, Scioto	Ohio
Stizostedion vitreum glaucum	Pike, blue	Lakes Erie and Ontario
Epioblasma sulcata delicata	Mussel, white cat's	Ohio, Michigan, Indiana

Source: Federal Register, U.S. Fish and Wildlife Service lists of endangered and threatened animals, October 27, 1976; Federal Register, U.S. Fish and Wildlife Service proposed list of endangered and threatened plants, June 16, 1976.

The Indiana bat ranges widely in the eastern United States, living in caves in winter and manmade structures or hollow trees during the summer. It could occur in the project area (2-267) possibly using streambanks for breeding habitat (2-268) but has not been reported in recent years. Most information indicatees that winter habitat is limiting. There are no caves on the lakefront site which would provide suitable winter hibernating shelter. Summer habitat of a limited quantity may be available in the flood plain areas of Racoon and Turkey Creek. It is not known if the quality of this habitat is adequate for the residing of Indiana bat since very little is known of their ecology. Similar habitat meeting the general requirements of this species occurs widely over its known range. Considering the facts - the extensive field search, the limited habitat of questionable quality coupled with the fact that wintering shelter requirements appear to be limiting, it appears highly unlikely that the lakefront site would be of any significant value to the Indiana bat. The peregrine falcon is decreasing in the area, appearing only as a rare migrant. (2-215) There is no indication of previous nesting in the area. (2-266) The American Osprey (Blue List, status undetermined) is not considered officially endangered by the U.S. Fish and Wildlife Service. However, it is decreasing in population in the area and is now known as only a spring or fall transient through the area (2-269), whereas it was believed to be a regular nester before 1900. (2-215) The eastern pigeon hawk, also of undetermined status, has decreased and is only a rare migrant. (2-215) Kirtland's warbler is thought to be an occasional migrant in the area (2-268) but has not been reported in Erie County. (2-269) A number of other bird species which are currently on the Blue List (2-270) have been sighted in the area: red-necked grebe (rare migrant), western Grebe (accidental visitor)*, white pelican (accidental visitor), double-crested cormorants (rare migrants), reddish egret (accidental visitors), black-crowned night heron (fairly common migrant), American bittern (uncommon breeder and migrant), canvasback (abundant migrant), sharp-shinned hawk (abundant spring migrant, rare breeder, uncommon fall migrant), Cooper's hawk (rare breeder, fairly common migrant), red-shouldered hawk (fairly common breeder and migrant), northern harrier (fairly common migrant, rare breeder), merlin (rare migrant), American kestrel (fairly common breeder and migrant), king rail (rare migrant), piping plover (rare migrant), upland sandpiper (uncommon breeder and migrant), yellow-billed cuckoo (uncommon breeder and migrant), barn owl (rare breeder and migrant), short-eared owl (uncommon migrant), common nighthawk (fairly common breeder and migrant), red-headed woodpeckers (fairly common breeder and migrant), hairy woodpecker (rare breeder, fairly cliff swallow (uncommon breeder and migrant), purple martin (abundant breeder and migrant), Bewick's wren (rare visitor), loggerhead shrike

* accidental visitor - recorded, but because of normal range, recurrence unlikely.

(rare migrant), yellow warbler (common breeder and migrant), yellow-breasted chat (uncommon migrant, rare breeder), grasshopper sparrow (uncommon breeder and migrant), Henslow's sparrow (uncommon breeder and migrant), and vesper sparrow (uncommon breeder and migrant). (2-269)

c) Species Protected by Ohio Law

2.983
The species currently protected by Ohio Law are shown in Table 2-450. Plants are not currently protected by the State of Ohio.

d) Ohio Protected Species Which May Inhabit the Regional Study Area

2.984
The river otter has a broad U.S. range and is reasonably likely to be found along stream or lake borders in this area. (67) The bobcat may be rarely found in some swamps and forests, although the Lake Erie shores are outside of its normal range. (2-271) The woodrat is not likely to be found here because its range is generally further south. The Indiana bat may occur but is unlikely, as discussed above.

2.985
The American peregrine falcon, bald eagle, Kirtland's warbler, upland sandpiper, and common tern have been seen in the area. Other possibly threatened species present in Ashtabula County are the short-tailed weasel (which is at the edge of its range), hooded merganser, least flycatcher, brown creeper, solitary vireo, prothonotary warbler, magnolia warbler, and orchard oriole. (2-272) The Cooper's hawk, barn owl, short eared owl and loggerhead shrike are also considered endangered in Ashtabula, Co. (2-234) The spotted turtle and wood turtle are reportedly rare but present. (2-272) The sharp-shinned hawk has been seen on the site in recent months. Its presence does not appear unusual, since it ranges through deciduous forests in the Northeast. It is quite common throughout Pennsylvania, but has restricted habitat in Ohio. The king rail's preferred habitat is freshwater marshes. Occasional nesting of the king rail has been recorded near Ashtabula and in the Pymatuning area. (2-266) It is probably on the Ohio list because of the decline in marsh habitats suitable for nesting.

2.986
One reptile and one amphibian on the Ohio endangered list range normally through the project region. The spotted turtle ranges throughout northern Ohio, preferring marshy meadows, bogs, and shallow bodies of water. This species has experienced habitat

Table 2-450

Endangered Wild Animals in Ohio

Ohio Revised Code, Section 1531.25, effective January 1, 1974, provides follows:

> "The Chief of the Division of Wildlife, with the approval of the Wildlife Council, shall adopt and may modify and repeal rules, in accordance with Chapter 119. of the Revised Code, restricting the taking or possession of native species of wild animals, or any eggs or off-spring thereof, that he finds to be threatened with statewide extinction. The rules shall identify the common and scientific names of each endangered species and shall be modified from time to time to include all species listed on the United States List of Native Endangered Fish and Wildlife pursuant to the Endangered Species Conservation Act of 1969, 83 Stat. 275, 16 U.S.C.A. 668cc-3, as amended, and that are native to this state or that migrate or are otherwise reasonably likely to occur within the state."
>
> "The rules shall provide for the taking of species threatened with statewide extinction, for zoological, educational, and scientific purposes, and for propagation in captivity to preserve the species, under written permits from the Chief. The rules shall in no way restrict the taking or possession of species listed on such United States list for zoological, educational, or scientific purposes, or for propagation in captivity to preserve the species, under a permit or license from the United States or any instrumentality thereof."
>
> "No person shall violate any rule adopted pursuant to this section."

A public hearing was held April 2, 1976, and the following list of endangered species has been established effective May 1, 1976:

Mammals

River otter, Luntra c. canadensis
Bobcat, Lynx r. rufus
Indiana bat, Myotis sodalis
Woodrat, Neotoma floridana magister

Table 2-450 (Continued)

Birds

American peregrine falcon, Falco peregrinus anatum
Sharp-shinned hawk, Accipiter striatus velox
Bald eagle, Haliaeetus leucocephalus
King rail, Rallus e. elegans
Kirtland's warbler, Dendroica kirtlandii
Upland sandpiper, Bartramia longicauda
Common tern, Sterna h. hirundo

Reptiles

Spotted turtle, Clemmys guttata
Northern copperbelly, Natrix erythrogaster neglecta
Eastern plains garter snake, Thamnophis r. radix

Amphibians

Blue-spotted salamander, Ambystoma laterale
Green salamander, Aneides aeneus
Cave salamander, Eurycea lucifuga
Four-toed salamander, Hemidactylum scutatum
Wehrle's salamander, Plethodon wehrlei

Fish

Ohio lamprey, Ichthyomyzon bdellium
Northern brook lamprey, Ichthomyzon fossor
Allegheny brook lamprey, Ichthyomyzon greeleyi
Silver lamprey, Ichthyomyzon unicuspis
American brook lamprey, Lampetra lamottei
Lake sturgeon, Acipenser fulvescens
Paddlefish, Polyodon spathula
Spotted gar, Lepisosteus oculatus
Shortnose gar, Lepisosteus platostomus
Mooneye, Hiodon tergisus
Cisco, Coregonus artedii
Great Lakes muskellunge, Esox m. masquinongy
Rosyside dace, Clinostomus funduloides
Tonguetied minnow, Exoglossum laurae
Bigmouth shiner, Notropis dorsalis
Pugnose minnow, Notropis emiliae
Bigeye shiner, Notripis boops
Ghost shiner, Notropis buchanani
Blacknose shiner, Notropis heterolepis
Silver chub, Hybopsis storeriana
Longnose sucker, Catostomus catostomus

Table 2-450 (Continued)

Fish (Cont.)

Greater redhorse, Moxostoma valenciennesi
Blue sucker, Cycleptus elongatus
River redhorse, Moxostoma carinatum
Lake chubsucker, Erimyzon sucetta
Scioto madtom, Noturus trautmani
Northern madtom, Noturus stigmosus
Mountain madtom, Noturus eleutherus
Pirateperch, Aphredoderus sayanus
Burbot, Lota lota
Banded killifish, Fundulus diaphanus
Iowa darter, Etheostoma exile
Longhead darter, Percina macrocephala
River darter, Percina shumardi
Eastern sand darter, Ammocrypta pellucida
Channel darter, Percina copelandi
Blue pike, Stizostedion vetreum glaucum
Tippecanoe darter, Etheostoma tippecanoe
Slenderhead darter, Percina phoxocephala
Spotted darter, Etheostoma maculatum

Crustaceans

Allegheny crayfish, Orconectes obscurus

Mollusks

Cob shell, Quadrula cylindrica
Club shell, Pleurobema clava
Fan shell, Cyprogenia stegaria
Orb mucket, Lampsilis orbiculata
White cat's paw, Epioblasma sulcata perobliqua
Northern riffle shell, Epioblasma torulosa rangiana
Simpson's shell, Simpsonaias ambiqua
Ridged pocketbook, Lamsilis ovata
Yellow sand shell, Lampsilis teres
Fragile heel-splitter, Potamilus laevissimus
Nodule shell, Quadrula nodulata
Monkeyface, Quadrula metanevra
Bullhead, Plethobasus cyphyus
Butterfly, Plagiola lineolata
Long-solid, Fusconaia subrotunda
Ohio pig-toe, Pleurobema cordatum

Table 2-450 (Continued)

It is unlawful for any person to import, transport, sell, offer for sale or possess any of the native endangered species of wild animals or hides or parts thereof, without first obtaining permission from the Wildlife Chief.

The Division of Wildlife welcomes factual information which tends to support the addition or removal of endangered status for a species. Such information may be submitted at any time to:

Chief, Division of Wildlife
Fountain Square
Columbus, Ohio 43224

Source: Ohio Department of Natural Resources, Division of Wildlife.

destruction, i.e., drainage. The four-toed salamander ranges throughout northeast and southern Ohio in boggy woodland ponds or sphagnaceous areas adjacent to woods. These habitats are not extensive in Ashtabula County.

e) Species Protected by Pennsylvania Law

2.987
The species which are protected by Pennsylvania Law are listed in Table 2-451. There are no protected mammal, bird or plant species listed in Pennsylvania, since the law enables protection of aquatic species only by the State Fish Commission.

f) Pennsylvania Protected Species Which May Inhabit the Regional Study Area

2.988
Among the reptiles and amphibians, four species may be found in the Regional Study Area. The softshell, a river turtle, has been observed although there is uncertainty as to whether it is the midland smooth. (2-219) The eastern hognose snake has been seen infrequently along the roadside. This species prefers sandy areas and open woods. The Massasauga is found in Crawford County, usually in bog or swamp environs, and may also occur in Erie County. The ranges of all of these species include the Regional Study Areas. The rough green snake, which does not normally range there, has been seen very infrequently. (2-219) Its favorite habitat is in dense vegetative growth overhanging streams and ponds, but it would not be expected on the proposed site.

g) Protected Terrestrial Species on the Proposed Lakefront Plant Site

2.989
No endangered plants or mammals listed by the Federal Government have been observed on the proposed Lakefront Plant site during 1977, but two species on the Ohio endangered species list were found on the site. The spotted turtle, listed as an Ohio endangered species, was observed in various locations on the site. There is apparently a strong viable population. (2-273) Small and adult individuals were found on the Ohio side in ditches along the south side of the N & W Railroad tracks and in adjoining swampy areas (refer to Figure 2-154). False hellebore, a rare plant found in swamps and poorly drained areas, was observed on the site. Other rare plants present on the site but not legally protected are shown on Figure 2-155.

2.990
The sharp-shinned hawk, listed as endangered in Ohio, has been seen on a number of occasions on the site, and a small number may be

Table 2-451

Endangered (1), Threatened (2), or Indeterminate (3)

Fishes, Amphibians or Reptiles of Pennsylvania

"This Collector's Permit does not authorize anyone to take any species considered to be threatened or endangered on the lists which follow. No species listed in the Bureau of Sport Fisheries and Wildlife publication Threatened Wildlife of the United States, or any additions to or revisions of that publication may be collected. Those species presently classified as indeterminate are permitted to be collected, since we need to obtain more information about their status (abundance and distribution) in Pennsylvania.

Classification categories are defined as follows:

1. Endangered: Actively threatened with extinction in the state. Continued survival unlikely without special protective measures.

2. Threatened: Not under immediate threat of extinction in the state, but occurring in such small numbers and/or in such restricted habitat that it could quickly cease to be a part of the state fauna.

3. Indeterminate: Apparently threatened or uncommon to rare, but insufficient data currently available on which to base a reliable assessment of status."

Table 2-451 (Continued)

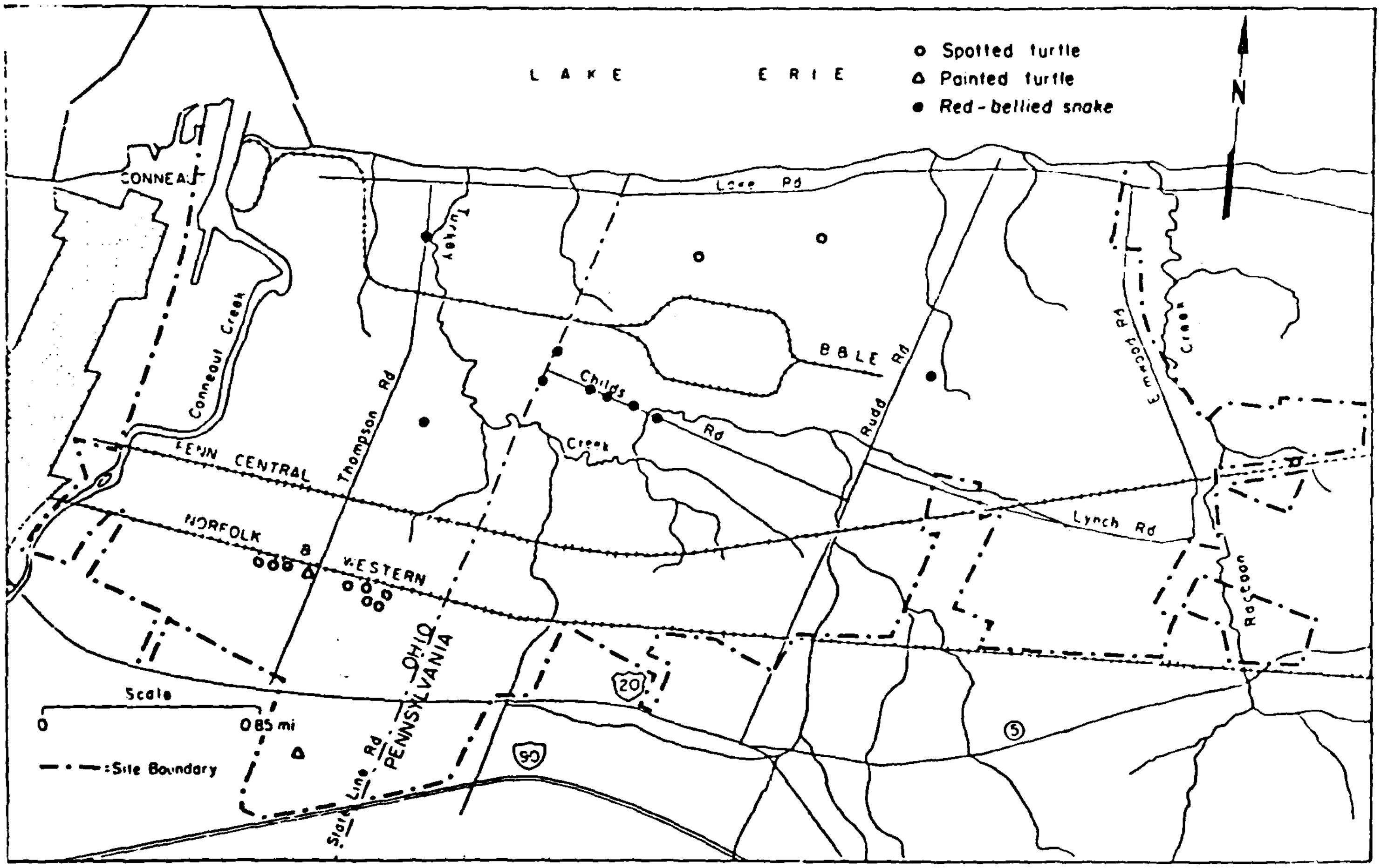
Fishes

Common Name	Scientific Name	Classification
Northern brook lamprey	Ichthyomyzon fosser	3
Silver lamprey	Ichthyomyzon unicuspis	3
Sea lamprey	Petromyzon marinus	3
Shortnose sturgeon	Acipenser brevirostrum	1
Lake sturgeon	Acipenser fulvescens	1
Atlantic sturgeon	Acipenser oxyrhynchus	3
Spotted gar	Lepisosteus oculatus	3
Cisco	Coregonus artedii	3
Lake whitefish	Coregonus clupeaformis	3
Southern redbelly dace	Phoxinus erythrogaster	3
Gravel chub	Hybopsis x-punctata	3
Hornyhead chub	Nocomis biguttatus	3
Silver chub	Hybopsis storeriana	3
River shiner	Notropis blennius	3
Blackchin shiner	Notropis heterodon	3
Blacknose shiner	Notropis heterolepis	3
Redfin shiner	Notropis umbratilis	3
Spotted sucker	Minytrema melanops	3
Black bullhead	Ictalurus melas	3
Mountain madtom	Noturus eleuthreus	3
Tadpole madtom	Noturus gyrinus	3
Brindled madtom	Noturus miurus	3
Northern madtom	Noturus stigmosus	3
Burbot	Lota lota	3
Threespine stickleback	Gasterosteous aculeatus	1
Warmouth	Lepomis gulosus	3

Table 2-451 (Continued)

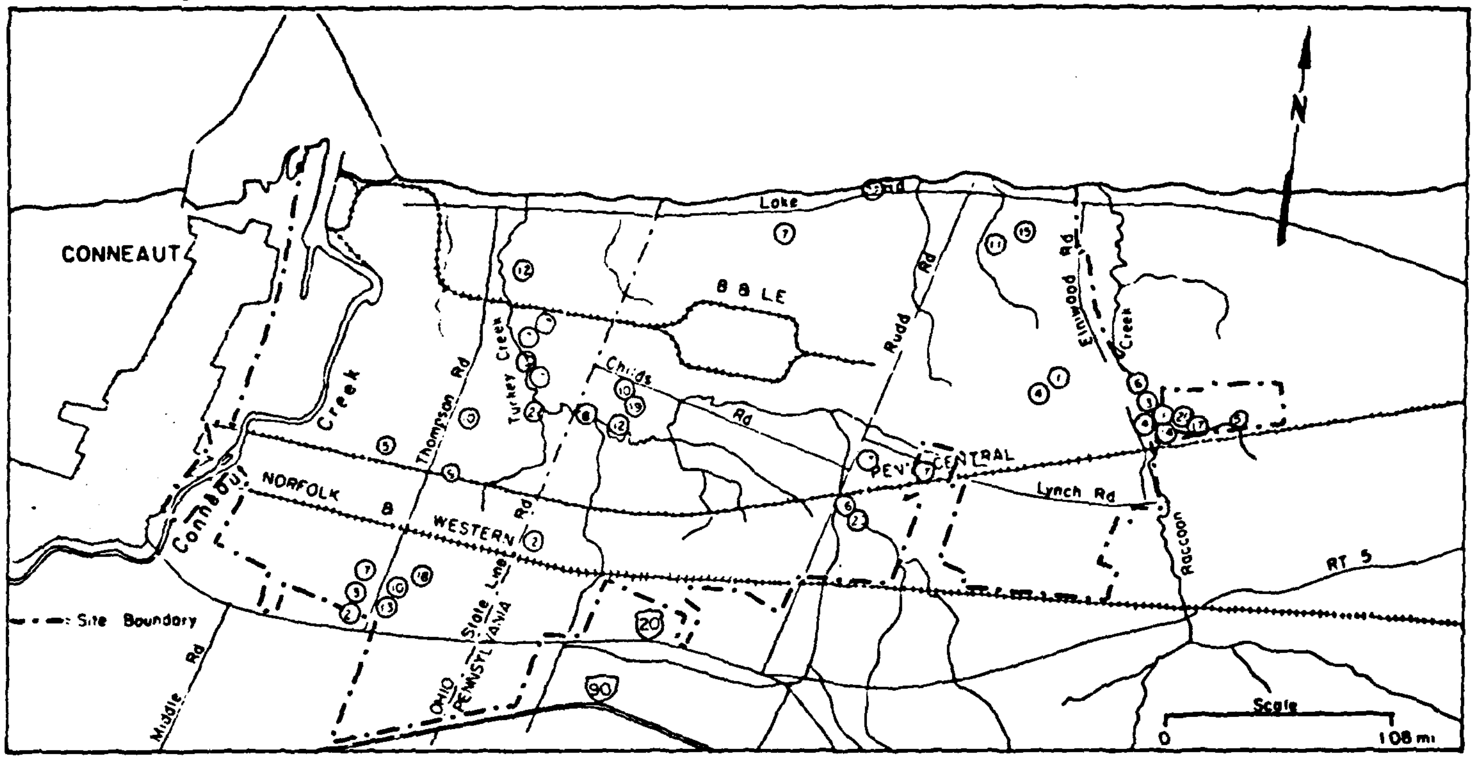
Common Name	Scientific Name	Classification
Orangespotted sunfish	Lepomis humilis	3
Longear sunfish	Lepomis megalotis	3
Spotted bass	Micropterus punctulatus	3
Eastern sand darter	Ammocrypta pellucida	2
Bluebreast darter	Etheostoma camurum	3
Spotted darter	Etheostoma maculatum	3
Tippecanoe darter	Etheostoma tippecanoe	3
Channel darter	Percina copelandi	3
Longhead darter	Percina macrocephala	3
Sauger	Stizostedion canadense	3
Blue pike	Stizostedion vitreum glaucum	1
	Amphibians and Reptiles	
Eastern tiger salamander	Ambystoma t. tigrinum	1
Green salamander	Aneides aeneus	2
Eastern mud salamander	Pseudotriton m. montanus	1
New Jersey chorus frog	Pseudacris triseriata kalmi	1
Coastal plain leopard frog	Rana utricularia	1
Eastern mud turtle	Kinosternon s. subrubrum	1
Red-bellied turtle	Crysemys rubriventris	1
Bog turtle	Clemmys muhlenbergi	1
Blanding's turtle	Emydoidea blandigingii	1
Midland smooth softshell	Trionyx m. muticus	1
Coal skink	Eumeces anthracinus	3
Broad-headed skink	Eumeces laticeps	3
Kirtland'd water snake	Clonophis kirtlandi	3
Eastern hognose snake	Heterodon platyrhinos	3
Eastern kingsnake	Lampropeltis g. getulus	3
Rough green snake	Opheodrys aestivalus	3
Timber rattlesnake	Crotalus horridus	3
Massasauge	Sistrurus catenatus	1

Source: Pennsylvania Fish Commission.



Source: Aquatic Ecology Associates.

FIGURE 2–154 DISTRIBUTION OF SPOTTED TURTLE, PAINTED TURTLE, AND RED-BELLIED SNAKE ON THE PROPOSED LAKEFRONT PLANT SITE–APRIL THROUGH OCTOBER, 1977



1. Acer Pennsylvanicum
2. Apocynum Sibiricum
3. Arisaema Triphyllum
4. Betula Lenta
5. Betula Populifolia
6. Botrychium Lanceolatum
7. Cinna Latifolia
8. Echinochloa Walteri
9. Euphorbia Glyptosperma
10. Gentian Saponaria
11. Larix Laricina
12. Lilium Superbum
13. Lobelia Puberula
14. Lonicera Oblongifolia
15. Magnolia Tripetala
16. Penstemon Laevigatus
17. Prunus Pennsylvanica
18. Salix Bebbiana
19. Sedum Telephium
20. Spiranthes Lucida
21. Veratrum Viride
22. Viburnum Opulus

Source: *Aquatic Ecology Associates.*

FIGURE 2–155 LOCATIONS OF AREAS WHERE RARE PLANTS WERE COLLECTED ON THE PROPOSED LAKEFRONT PLANT SITE

resident. An osprey has been sighted flying offshore on the site. Other endangered species such as marten, river otter, and bobcat, which normally range through the area might be found but have not been recorded on site, as of 15 November 1977.

Protected Fishes in the Lake Erie Drainage

2.991
Species of fishes in the Lake Erie drainage may come under protection by Federal, or State agencies. The comparative listing of such designated species is given in Table 2-452. Included in this table is the Ohio Historical Society listing that suggests species for protection, although this list does not represent legal protection. Lake Erie may have become as much as 2°F warmer in the recent past. Many of its tributaries have been dammed and a great increase in siltation in Lake Erie and many tributaries has been observed. In addition, aquatic vegetation from shallower areas has decreased and many marshes have been drained or otherwise been made inaccessible to lake fishes. These conditions, along with the range limits and fishing pressure account for the large number of species shown on this combined list.

2.992
Those species for which Lake Erie and/or its tributaries represent the northern extent of their range include:

Spotted gar, Lepisosteus oculatus;
Southern redbelly dace, Phoxinus erythrogaster;
Pugnose minnow, Notropis emiliae;
Bigmouth shiner, Notropis dorsalis; and
Warmouth, Lepomis gulosus.

Those species which require cooler water at some point during their life cycle for which Lake Erie and/or its tributaries are at the southern extent of their range include:

Lake herring, Coregonus artedii;
Lake whitefish, Coregonus clupeaformis;
Longnoise sucker, Catostomus catostomus; and
Burbot, Lota lota.

The limiting stress on these species may have been caused at lease in part by the 2°F increase in average lake temperatures.

2.993
A number of species require clear water in shallow areas such as pools, bays, or harbors. Many of these also require submerged

Table 2-452

Species Protected by Federal, or State Law

Federal	Ohio	Pennsylvania	Ohio Historical
	Silver lamprey (Ichthyomyzon unicuspis)	Silver lamprey (3)* (Ichthyomyzon unicuspis)	
	Northern brook lamprey (Ichthyomyzon fosser)	Northern brook lamprey(3) (Ichthyomyzon fosser)	
	Allegheny brook lamprey* (Ichthyomyzon greeleyi)		
		Sea lamprey (Petromyzon marinus)	
	American brook lamprey (Lampetra lamottei)		
	Ohio lamprey* (Ichthyomyzon bdellium)		
	Paddlefish (Polydon spathula)		
	Lake sturgeon (Acipenser fulvescens)	Lake sturgeon (1) (Acipenser fulvescens)	Lake sturgeon (E) (Acipenser fulvescens)
		Shortnose sturgeon (1)* (Acipenser brevirostrum)	
		Atlantic sturgeon (3) (Acipenser oxyrhynchus)	
	Spotted gar (Lepisosteus oculatus)	Spotted gar (3) (Lepisosteus oculatus)	
	Shortnose gar* (Lepisosteus platostomus)		
	Mooneye (Hiodon tergisus)		
	Cisco (Coregonus artedii)	Cisco (3) (Coregonus artedii)	
		Lake Whitefish (3) (Coregonus clupeaformis)	Lake Whitefish (t) (Coregonus clupeaformis)
	Great Lakes muskellunge (Esox masquinongy)		Great Lakes muskellunge (Esox masquinongy)

Table 2-452 (Continued)

Federal	Ohio	Pennsylvania	Ohio Historical
			Longnose dace (P) (Rhinichthys cataractae)
		Southern redbelly dace (3) (Phoxinus erythrogaster)	
	Rosyside dace* (Clinostromus funduloides)		
	Pugnose minnow (Notropis emiliae)		
	Tonguetied minnow* (Exoglossum laurae)		
		Blackchin shiner (3) (Notropis heterodor)	
	Bigeye shiner (Notropis boops)		
		Redfin shiner (3) (Notropis umbratilis)	
	Bigmouth snier (Notropis dorsalis)		
	Blacknose shiner (Notropis heterolepis)	Blacknose shiner (3) (Notropis heterolepis)	
	Ghost shiner* (Notropis buchanani)		
		River shiner (3)* (Notropis blennius)	
		Horneyhead chub (3) (Nocomis biguttatus)	
	Silver chub (Hybopsis storeriana)	Silver chub (3) (Hybopsis storeriana)	
		Gravel chub (3) (Hybopis x-punctata)	
	Longnose sucker (Catostomus catostomus)		Longnose sucker (Catostomus catostomus)
		Spotted sucker (3) (Minytrema melanops)	

Table 2-452 (Continued)

Federal	Ohio	Pennsylvania	Ohio Historical
	Lake chubsucker (Erimyzon sucetta)		
	Greater redhorse (Moxostoma valenciennesi)		
	Blue sucker* (Cycleptus elongatus)		
	River redhorse* (Moxostoma carinatum)		
		Black Bullhead (3) (Ictalurus melas)	
	Northern madtom (Noturus stigmosus)	Northern madtom (3) (Noturus stigmosus)	
		Brindled madtom (3) (Noturus miurus)	
		Tadpole madtom (3) (Noturus gyrinus)	
	Scioto madtom* (Noturus trautmani)		
	Mountain madtom* (Noturus eleutyerus)	Mountain madtom (3)* (Noturus eleutherus)	
	Banded killifish (Fundulus diaphanus)		
	Burbot (Lota lota)	Burbot (3) (Lota lota)	Burbot (t) (Lota lota)
		Threespine stickleback (1)* (Gasterosteous aculeatus)	
	Pirate perch (Aphredoderus sayanus)		
		Warmouth (3) (Lepomis gulosus)	
		Orangespotted sunfish (3) (Lepomis humilis)	
		Longear sunfish (3) (Lepomis megalotis)	

Table 2-452 (Continued)

Federal	Ohio	Pennsylvania	Ohio Historical
	River darter (*Percina shumardi*)		
	Eastern sand darter (*Ammocrypta pellucida*)	Eastern sand darte. (2) (*Ammocrypta pellucida*)	
	Iowa darter (*Etheostoma exile*)		
	Channel darter (*Percina copelandi*)	Channel darter (3) (*Percina copelandi*)	Channel darter (E)E (*Percina copelandi*)
		Spotted bass* (*Micropterus punctulatus*)	
	Longhead darter* (*Percina macrocephala*)	Longhead darter (3)* (*Percina macrocephala*)	
	Tippecanoe darter* (*Etheostoma tippecanoe*)	Tippecanoe darter (3)* *Etheostoma tippecanoe*)	
	Slenderhead darter* (*Percina phoxocephala*)		
	Spotted darter* (*Etheostoma maculatum*)	Spotted darter (3)* (*Etheostoma maculatum*)	
		Bluebreast darter (3)* (*Etheostoma camurum*)	
		Sauger (3) (*Stizostedion canadense*)	Sauger (U) (*Stizostedion canadense*)
Blue pike (*Stizostedion vitreum glaucum*)		Blue pike (1) (*Stizostedion vitreum glaucum*)	Blue pike (E) (*Stizostedion vitreum glaucum*)

Key: (from the Pennsylvania list)
(1) Endangered - actively threatened with extinction in the state
(2) Threatened - not under immediate threat of extinction
(3) Indeterminate - apparently threatened, uncommon, but insufficient data
(from Historical society list)
(E) Endangered
(P) Peripheral
(U) Undetermined
(T) Threatened

*Probably does not occur in the Lake Erie drainage.

aquatic vegetation and some utilization of marsh habitat. These species include:

Spotted gar, _Lepisosteus oculatus_;
Great Lakes muskellunge, _Esox m. masquinongy_;
Blacknose shiner, _Notropis heterolepis_;
Lake chubsucker, _Erimyzon sucetta_;
Greater redhorse, _Moxostoma valenciennesi_;
Brindled madtom, _Noturus miurus_;
Western banded killifish, _Fundulus diaphanus_;
Iowa darter, _Etheostoma exile_; and
Channel darter, _Percina copelandi_.

The existence of aquatic vegetation is not a necessary requirement for the latter two species.

2.994
Species that might be found in lower gradient streams and rivers at some point in their life cycle, and that require clear, unsilted water include:

Silver lamprey, _Ichthyomyzon unicuspis_;
Northern brook lamprey, _Ichthyomyzon fossor_;
Sea lamprey, _Petromyzon marinus_;
American brook lamprey, _Lampetra lamottei_;
Mooneye, _Hiodon tergisus_;
Pugnose minnow, _Notropis emiliae_;
Blackchin shiner, _Notropis heterodon_;
Redfin shiner, _Notropis umbratilis_;
Hornyhead chub, _Nocomis biguttatus_;
Silver chub, _Hybopsis storeriana_;
Spotted sucker, _Minytrema melanops_;
Brindled madtom, _Noturus miurus_;
Tadpole madtom, _Noturus gyrinus_;
Western banded killifish, _Fundulus diaphanus_;
Northern Longear sunfish, _Lepomis megalotis_; and
Iowa darter, _Etheostoma exile_.

2.995
Species that might be found in moderate to high gradient streams and rivers at some point in their life cycle and also require clear, unsilted water include:

Silver lamprey, _Ichthyomyzon unicuspis_;
Northern brook lamprey, _Ichthyomyzon fossor_;
Sea lamprey, _Petromyzon marinus_;
American brook lamprey, _Lampetra lamottei_;
Lake sturgeon, _Acipenser fulvescens_;

Mooneye, Hiodon tergisus;
Longnose dace, Rhinichthys catatactae;
Bigmouth shiner, Notropis dorsalis;
River chub, Notropis blennius;
River darter, Percina shumardi;
Eastern sand darter, Ammocrypta pellucida; and
Northern madtom, Noturus stigmosus.

2.996
A number of these threatened species that are listed on the Ohio and Pennsylvania lists have a limited range that includes the Lake Erie basin.. These might include:

Northern Brook Lamprey, Ichthyomyzon fossor;
Greater Redhorse, Moxostoma valenciennesi; and
Eastern Sand Darter, Ammocrypta pellucida.

2.997
Since the establishment of the Sea Lamprey in the Great Lakes and subsequent problems with this parasitic species, Lamprey control programs have been conducted in a number of the Great Lakes. Such programs may have affected all the species of Lamprey that are in the Lake Erie basin, including its tributaries. Only a small number of paddlefish and bigeye shiner have ever been reported for Lake Erie. It is possible that these species were never extensively established in Lake Erie.

2.998
The Blue Pike is listed as endangered on the Pennslyvania List, listed as endangered on the Ohio list and listed as endangered on the Federal list. The U.S. Department of the Interior has suggested that this species be declared extinct. If it is not extinct, it occurs in very small numbers in the cooler, deeper areas of Lake Erie and possibly Lake Ontario. Oxygen depletion in spawning areas in the spring in central Lake Erie as well as extensive fishing pressure may have contributed to the decline of this species, but causative factors are unknown. Furthermore, few remaining numbers may have interbred with the larger populations of walleye in the Lake.

2.999
The sauger is included on the Pennsylvania Endangered Species List but has not been included on the Ohio list, essentially because it is being stocked by the Ohio Division of Wildlife in Sandusky Bay. Sauger are also related to walleye and blue pike and thought to interbreed with the former species. One sauger was collected in lower Conneaut Creek (Ohio) by the Aquatic Ecology Associates Sampling Program. The U.S. Fish and Wildlife Service found what was initially identified as an Orange Spotted Sunfish in Turkey Creek.

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CHAPTER THREE: RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS

Existing Land Use Plans and Other Regulatory Requirements

3.1
The United States Steel Corporation will be required to comply with all applicable laws, rules, regulations, and standards relevant to the location, design, construction, operation, and maintenance of the proposed Lakefront Steel plant. In addition, the applicant will be required to comply with all Federal, State, and local land use plans. The proposed facility will straddle the Ohio-Pennsylvania State line and will occupy land within the political boundaries of Conneaut City, Ohio, and Springfield Township, Pennsylvania. Under these circumstances, the applicant will be required to meet the regulatory requirements and land use controls of both States and their respective local governments. Regulations pertaining to the construction and operation of the proposed plant are presented in Chapter One of this statement. A description of the applicable land use plans, policies, and controls is presented in Chapter Two. The impact of the proposed action and secondary development on land use is presented in Chapter Four of this statement.

Applicable Land Use Plans

3.2
Existing land use plans considered in this study include those of Ashtabula County, Ohio, Erie and Crawford Counties, Pennsylvania, and various communities within those counties. The Ohio and Pennsylvania Coastal Zone Management Plans, still in their formulative stages, were also considered. These plans serve as reference points for the identification of long-range land use objectives in the Regional Study Area. The directly applicable regulatory provisions concerning the proposed Lakefront site are the zoning and subdivision regulations of the two communities in the Local Study Area, namely Conneaut and Springfield.

Coordination with Land Use Planning Agencies

Coordination by the Applicant

3.3
The following agencies and individuals with major responsibility for

land use considerations were interviewed in the field by the applicant's consultant:

Ohio

Department of Community Affairs: Thomas Daley

Department of Natural Resources/Office of Coastal Zone Management: Bruce MacPherson

Ashtabula County Planning Commission: Eber Wright, Ray Shore, Hugh Thomas

Conneaut City Zoning Board: Mrs. M. Smith

Pennsylvania

Office of State Planning and Development: Robert Benko, Mark McClellan

Department of Environmental Resources: Eugene Eisenbise, David Blair, Mark Fiedler

Erie County Metropolitan Planning Commission: Christopher Capotis, Larry Bassalt, Tom Debellow

Crawford County Planning Commission: Edward Edinger

Springfield Township Zoning Board: George Holliday

The land use plans administered by each of the above were given consideration during the overall development of the proposed facility. In general, all of the named individuals indicated that the proposed facility could be in compliance with the applicable land use plans, but that a final judgement could not be made until detailed engineering and design were completed for the Lakefront facility.

Coordination by the Buffalo District, Corps of Engineers

3.4
The Buffalo District Engineer requested those public planning agencies with a particular interest in northeastern Ohio and northwestern Pennsylvania to evaluate the relationship the proposed Lakefront Plant will have on their respective land use plans. Specifically, these planning agencies were requested to analyze potential areas of compatibility or conflict between the proposed project and the objectives and specific terms of existing or anticipated land use policies and controls that have been formulated for the plant site and the

surrounding region. A list of the agencies contacted is presented below:

- Mid-Atlantic Federal Regional Council
- U.S. Department of Housing and Urban Development
- Ohio Department of Natural Resources
- Pennsylvania Office of State Planning & Development
- Ashtabula County Council of Governments
- Ashtabula County Planning Commission
- Erie County Metropolitan Planning Commission
- Ashtabula Metropolitan Housing Authority
- Zoning Officer of Springfield Township
- Conneaut Planning Commission

Written responses were received from the Mid-Atlantic Federal Regional Council, Ashtabula County Planning Commission, the Pennsylvania Office of State Planning and Development and the city of Conneaut. The chairman of the Federal Regional Council advised that the proposed project was consistent with the goals of the President's national urban policy. Representatives of Ashtabula County agencies indicated that the proposed action appears to be in keeping with the overall land use plans of the county. The response from the Commonwealth of Pennsylvania indicated that several strategies are being developed which could be used to evaluate large scale development proposals such as the one proposed by the U.S. Steel Corporation. Conneaut officials provided a zoning map and copies of related zoning ordinances. Copies of the letters of coordination and those agency responses received are appended to this statement.

Compatibility of the Lakefront Plant with Local Land Use and Zoning Plans

3.5
The city of Conneaut zoned the majority of the proposed site as "Heavy Industrial" many years ago. The northwest portion of the site lies adjacent to an existing port facility and development of a steel plant in this area represents a continuation of an already existing industrial corridor. However, such development, if allowed to occur, would be accomplished at the expense of the wooded and open space areas east of the harbor complex. The southern portion of the proposed site (adjoining suburban and rural residential zones, and vacant areas near Interstate I-90) retains the designation "Light Industrial."

3.6
The Pennsylvania portion of the site lies within Springfield Township and up until September 1977 was zoned for agricultural or conservation uses. However, during this month, the portion of the site on

which the proposed facility would be built was rezoned "heavy industrial" while the rest of the site retained the designations "light industrial," "rural residential," "suburban residential," and "conservation-recreational." The applicant had requested that the entire Lakefront site be designated heavy industrial but to date no action has been taken on this request. Raccoon Creek Park, a county facility, borders the eastern perimeter of the Lakefront site. Although this facility will not be directly affected by plant structures, its aesthetic value may be impaired by plant-related noise, dust, and process emissions during construction and regular operation. If this should occur, the proposed project may conflict with the Coastal Zone Management Plans currently being developed by the Commonwealth of Pennsylvania. Overall the proposed action does not appear to conflict with existing land use plans, policies, or controls administered by the local governments at this time.

Plant Related Secondary Growth and Applicable Land Use Plans

3.7
The Regional Study Area is essentially rural in character, with major population centers concentrated in the coastal zone of the Principal Study Area. This observation is reflected in the land use plans of the area communities. In the Pennsylvania Coastal Communities, from Springfield Township east to the city of Erie, 50 percent of the land has been designated for agriculture and/or conservation. Less than 10 percent of the land in these communities has been designated for commercial and industrial uses combined. The Coastal Communities in Ohio, from Conneaut City west through Saybrook Township, represent a somewhat similar degree of urbanization but a somewhat different planning approach. A far larger percentage (i.e., 15-30 percent) of land in these Ohio communities has been designated for industrial uses. This is especially true around the city of Ashtabula. Projected population increases, over the 1979-1990 projection period, due to the proposed facility, are not large enough to measurably change existing land use patterns as a whole. However, more intensive use of land, especially in residential areas, is projected, with the most significant changes expected to occur in the Local Study Area, where the facility would be located.

3.8
Although land use plans have designated large areas for residential uses and more than sufficient space is available to accommodate the projected population increments through 1990, there are certain constraints that would apply to both baseline and plant-related growth. Land suitability for on-lot sewage systems is limited. In areas where municipal sewage systems are at capacity, have not been built, or where interceptor sewage lines have not been extended, certain types of development could be restricted. Package plant

systems could be used for some developments in such areas. However, these systems, especially in large numbers, would have an adverse impact on the small, environmentally sensitive streams that exist in this portion of the Lake Erie drainage basin. This problem would be most severe in the Local Study Area: Springfield Township and West Springfield Borough are not sewered, and plans for connections with existing or proposed regional systems in Northwest Erie County have not been formalized; the major undeveloped portions of the city of Conneaut are not, at present, served by its municipal sewage system, and the system in the older parts of the city experiences infiltration problems.

3.9
A similar situation exists in terms of water supply in some municipalities. Springfield Township and East Springfield Borough are examples of municipalities that do not have a public water supply and where supplying water to predicted new populations could be problematic in the short term.

3.10
The location of solid waste disposal sites is already a problem in the Coastal Communities of both states. Existing facilities are near capacity under baseline conditions, with problems foreseen in the near future, with or without the proposed project.

3.11
The only major new highway construction projected in this report consists of access routes to the proposed facility from I-90. One alternative to the proposed direct access route, the Route 20 bypass, would be built across Conneaut Creek and its adjacent flood plain, as well as through residential areas. As planned, this bypass alternative would appear to be in conflict with existing residential uses, land use plans, and policies in Conneaut. The proposed "East Access Road" and "State Line Road direct access route" would pass through a much smaller amount of developed area, would not adversely impact a major stream, and would require allocation of less land.

3.12
Projections of development levels unlinked to the plant, and over the long term, beyond the scope of this study, are speculative. Should more rapid urbanization and industrialization occur, demands for additional land beyond that designated for such development in existing land use plans would also occur. This could begin to impinge on valued natural features or those existing portions of land presently designated as open space or those of prime quality for agricultural uses. If this should occur, the essentially rural character of this area could change.

Measures Available to Reconcile Conflicts with Applicable Land Use Plans, Policies, and Controls

Measures Available to the Applicant

3.13
The measures available to the applicant to reconcile conflicts with applicable land use plans could include the following: leaving vegetated buffer zones between industrial activities and residential and recreational areas; and advancing revenues to the Local Study Area communities to help offset costs of construction of infrastructure needed for increased population-related development. The applicant has indicated that a greenbelt would exist around the plant.

Other Measures

3.14
Development in keeping with the planned character of an area can be accomplished with the design of or use of existing institutional measures. Some municipalities in the Regional Study Area do not have zoning or subdivision codes. Identification of "prime and unique farmlands" and environmentally sensitive areas (including streams, flood plains, and wetlands) can aid in planning design implementation. The Coastal Zone Management Programs could provide initial information on such resources in the Coastal Communities. Relatively less information exists for much of the Regional Study Area. Institutional measures available to communities in the Regional Study Area include:

Planning, implemented through zoning and subdivision, for all necessary uses, including solid waste disposal and other municipal common uses, as a means for minimizing zoning changes;

Implementing general and case-by-case assessment of the environmental impact potential of development types permitted by zoning and subdivision codes, and developing code provisions for such assessment if they do not exist; and,

Minimizing spot zoning or variances that are not in keeping with the local or regional land use plans.

Major State and/or Federal initiatives (such as tax incentive programs, purchase of development easement, etc.) may be the only measures capable of mitigating an overall trend toward decreasing emphasis on agricultural land use, assuming this is a generally desired growth objective.